The Welding Engineer

Founded by L. B. Mackenzie, 1916

NOVEMBER, 1925 — VOL. 10, No. 11

$3.00 per year in U. S. — 608 S. Dearborn St., Chicago, Ill. — Reg. U. S. Pat. Office — $4.00 per year abroad

What is the Advantage of High Purity Oxygen in Oxyacetylene Cutting?

Buy Your Oxygen On Specification For Purity

AIRCO OXYGEN IS 99.5% PURE IN THE CYLINDER

The Purest Oxygen Is Always the Most Economical

Airco 99.5% High Purity Oxygen cuts 16% more ¾ inch steel plate than the same volume of 99% Oxygen

AIRCO
OXYGEN
AIRCO
AIRCO
With the same volume of Oxygen, same pressure and same tip—
This cut made with Airco 99.5% Pure Oxygen
This cut made with 99% Oxygen

AIR REDUCTION SALES COMPANY

Manufacturers of Airco Oxygen, Airco Acetylene, Airco-National Carbide, Airco-Davis-Bournonville Equipment and Supplies.

AIRCO — DAVIS BOURNONVILLE

26 Airco Oxygen Plants — 15 Airco Acetylene Plants — 2 Airco Calorene Plants
17 Airco District Offices — 14 Airco Repair Stations — 85 Airco Distributing Points
Airco Apparatus Factories and Laboratories at Jersey City and Elizabethport, N. J.

Home Office: 342 Madison Avenue, New York, N. Y.

Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill. Under the Act of March 3, 1879.

Put balloon tires on your welding

OXWELD service follows the user. It frequently begins with a survey of a plant and with recommendations as to where the oxy-acetylene process can be used. Oxweld engineers and field men can then place at your disposal all the experience of the Oxweld staff. Back of them is the Oxweld engineering laboratory service. All this is at your service as an Oxweld user.

BALLOON TIRES on your car smooth the road for you. Their elasticity makes the bumps and ruts disappear and conserves all the useful energy of the engine.

So it is with the Oxweld blowpipe. It smooths out the welding road for you. Its low-pressure flame is not harsh and snapping; nor is it blown away from the metal by the force of a high-pressure blast. All the energy of the burning gases is concentrated onto the metal itself and, in addition, you get an easier, surer control of the weld.

Welders who have used Oxweld equipment understand this. They know what it means to take the bumps and ruts out of a welding job. They know, too, the feeling of the Oxweld blowpipe, as it blazes a smooth welding trail.

For better welding—Oxweld with low pressure.

Oxweld Acetylene Company

LONG ISLAND CITY, N.Y.
Thompson Ave. & Orton St.

CHICAGO
3642 Jasper Place

SAN FRANCISCO
1050 Mission Street

Oxweld

WELDING AND CUTTING APPARATUS

WORLD'S LARGEST MANUFACTURERS OF WELDING AND CUTTING EQUIPMENT

Soft

WHILE the welder's job is never "soft," a "soft" flame makes it easier and his work much more effective.

To get a soft flame, you must have the right torch—one that will thoroughly mix the gas and deliver it in about equal volumes at a low velocity.

Purox welding torches insure this much-desired "soft," neutral flame, delivering perfectly mixed gases in the right proportion at the right velocity, which produces an ideal welding flame; clean, easy-flowing metal; and a solid, supremely satisfactory weld.

Why not make your welding flame soft, your work easier and your welding better with Purox torches? The nearest Purox office will be glad to send you a torch catalogue and price list. Ask for them today.

PUROX COMPANY

GENERAL OFFICES: DENVER, COLORADO

BRANCH OFFICES:

2101 Blake St.
Denver, Colo.

2305 East 52nd St.
Los Angeles, Calif.

1135 Third St.
Oakland, Calif.

620 East Hancock Ave.
Detroit, Mich.

71 Steuart St.
San Francisco, Calif.

2020 East 22nd St.
Cleveland, Ohio

362 Pierpont Ave.
Salt Lake City, Utah

213 West Ohio St.
N. S., Pittsburgh, Pa.

South Front and Girod Streets
New Orleans, La.

1739 Walnut St.
Kansas City, Mo.

2920 First Ave. South
Seattle, Washington

39 Cortlandt St.
New York, N. Y.

113 North Third St., Portland, Oregon

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co.
Purox Co.

AIR LIQUEFACTION OXYGEN PRODUCING PLANTS
M. Keith Dunham
Heylandt Sales Co.

ALUMINO-THERMIC WELDING
Alumino-Thermic Corporation

ALUMINUM SOLDER
Wm. Cramp & Sons.

ANNEALING FURNACES
Buffalo Dental Mfg. Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.

APRONS (Asbestos)
Chicago Eye Shield Co.
Ideal Face Shield Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BLOW PIPES
See "Torches."

BOOKS
The Welding Engineer Pub. Co.
Electric Arc Cutting & Welding Co

BRAZING OUTFITS
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
General Welding and Equipment Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.

BRONZE FILLER RODS
American Brass Co.
Bierman Everett Foundry Co.
Central Steel & Wire Co.
Wm. Cramp & Sons
Steel Sales Corp.

BUFFERS
N. A. Strand & Co.
Wodack Electric Tool Corp.

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.

CARBIDE
Air Reduction Sales Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBIDE (Compressed in Cakes)
Carbic Mfg. Co.

CARBON (Blocks, Paste, Electrodes, etc.)
Air Reduction Sales Co.
Electric Arc Cutting & Welding Co.
National Carbon Co.
Oxweld Acetylene Co.
U. S. Welding Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
U. S. Welding Co.

CAST IRON SOLDER
Wm. Cramp & Sons

CUTTING ELECTRODES (Electric Arc)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
Mattice Engineering Co., Inc.
National Carbon Co.
Todd Shipyards Corp.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CYLINDERS
M. Keith Dunham
Wm. Wharton Jr. & Co.

DRILLS, PORTABLE ELECTRIC
N. A. Strand & Co.
Wodack Electric Tool Corp.

ELECTRIC ARC WELDING OUTFITS
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Goodman Electric Machinery Co.
Lincoln Electric Co.
H. E. Steinbock
Todd Shipyards Corp.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Wm. Cramp & Sons
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
Mattice Engineering Co., Inc.
Manganese Steel Forge Co.
Morris-Wheeler Co.
Page Steel & Wire Co.
H. E. Steinbock
Reid-Avery Co.
Roebling, John A., Sons Co.
Steel Sales Corp.
Seneca Wire & Mfg. Co.
Stoody Co.
Una Welding and Bonding Co.
Wickwire-Spencer
Wilson Welder & Metals Co.

ELECTRODE HOLDERS
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
C. H. Hollup Corp.
Lincoln Electric Co.
H. E. Steinbock
Stoody Co.
Todd Shipyards Corp.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
Burdett Oxygen Co.
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
American Optical Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Morris, Wheeler & Co.
H. E. Steinbock
Straus & Bengeleisen
Todd Shipyards Corp.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

FILLER RODS
Air Reduction Sales Co.
American Brass Co.
Bierman-Everett Foundry Co.
Central Steel & Wire Co.
Wm. Cramp & Sons
C. H. Hollup Corp.
Manganese Steel Forge Co.
Morris-Wheeler & Co.
Oxweld Acetylene Co.
Page Steel & Wire Co.
Purox Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Steel Sales Corp.
Seneca Wire & Mfg. Co.
Stoody Co.
Torchweld Equipment Co.
Wickwire-Spencer

FIREPROOF PLASTIC MATERIAL
Air Reduction Sales Co.
Joseph Dixon Crucible Co.
Modern Engineering Co.
National Carbon Co.
U. S. Welding Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Bastian-Blessing Co.
Bierman Everett Foundry Co.
Griesheim
The Hoxite Co.
Metal & Thermit Corp.
Central Steel & Wire Co.
Morey Flux & Chemical Co.
Morris, Wheeler & Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

GLOVES (Asbestos)
Chicago Eye Shield Co.
Ideal Face Shield Co.

GAUGES
National Gauge & Equipment Co.
U. S. Gauge Co.

GENERATORS (Acetylene)
Air Reduction Sales Co.
Bastian-Blessing Co.
M. Keith Dunham
Griesheim
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
U. S. Welding Co.

GOGGLES
American Optical Co.
Chicago Eye Shield Co.
Ideal Face Shield Co.
Straus & Bengeleisen
Willson Goggles, Inc.

GRAPHITE (Rods, Blocks, Paste, Etc.)
Joseph Dixon Crucible Co.

GRINDERS (Portable Electric)
N. A. Strand & Co.
Wodack Electric Tool Corp.

HELMETS (Arc Welding)
Allan Mfg. & Welding Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Morris, Wheeler & Co.
H. E. Steinbock
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

LEAD WELDING UNITS
Air Reduction Sales Co.
Bastian-Blessing Co.
Buffalo Dental Mfg. Co.
Carbic Mfg. Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
U. S. Welding Co.

Electric Welders:

Send your name and address to

Wilson Welder & Metals Co. Inc.,
Wilson Building, Hoboken, N. J.

Insure your welding jobs being done right the *first time* by always using Wilson "Color-tipt" Welding Wire — the utmost in quality, uniformity and economy.

We will send you a sample of grade No. 20 Wilson Wire for welding brass and bronze; also grade No. 12 for cast iron.

Your name will be put on our mailing list for bulletins and data on arc welding.

See Wilson Exhibit
Power and Mechanical Engineering Exposition
BOOTHS 485-486
Grand Central Palace
New York
Nov. 30 — Dec. 5

WILSON WELDER & METALS CO. INC., WILSON BLDG., HOBOKEN, NEW JERSEY

WILSON

WELDING MACHINES AND WELDING WIRE

Wilson Welder & Metals Co., Inc.,
Wilson Bldg., Hoboken, N. J.

Please send me without charge samples of Grade 20 and Grade 12 Wilson Colortipt Welding Wire which you offer to welders in the November issue of The Welding Engineer.

NAME _____

Street _____ City _____ State _____

LIGHTERS (For Gas Torches)
Air Reduction Sales Co.
Bastian-Blessing Co.
Buffalo Dental Mfg. Co.
Carbic Mfg. Co.
General Welding and Equipment Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

MANIFOLDS
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Griesheim
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Mach. Co.
Torchweld Equipment Co.
U. S. Welding Co.

MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
Air Reduction Sales Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

MONEL METAL RODS AND ELECTRODE
Central Steel & Wire Co.
Wilson Welder & Metals Co.

NEEDLE VALVES
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
General Welding and Equipment Co.
Griesheim
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
U. S. Welding Co.

NITROGEN
Air Reduction Sales Co.
Gas Products Association
Linde Air Products Co.
International Oxygen Co.

OXYGEN
Air Reduction Sales Co.
Gas Products Association
International Oxygen Co .
Linde Air Products Co.
Purox Co.

PREHEATING DEVICES AND OVENS
Bastian-Blessing Co.
Buffalo Dental Mfg. Co.
Metal & Thermit Corp.

RAIL BONDS
Una Welding and Bonding Co.

RAIL JOINT WELDERS
Una Welding and Bonding Co.

REAMERS (Portable Electric)
N. A. Strand & Co.
Wodack Electric Tool Corp.

REGULATORS
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Griesheim
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.

RESISTANCE WELDING MACHINERY
Acme Electric Welder Co.

TANK CONNECTIONS
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Griesheim
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.

THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Welding and Cutting)
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Griesheim
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
International Oxygen Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.

TRUCKS (Cylinder)
Bastian-Blessing Co.
Carbic Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

VALVES
Air Reduction Sales Co.
Bastian-Blessing Co.
International Oxygen Co.
Sherwood Mfg. Co.

WELDING COMPOUND (for Shape Weld
Air Reduction Sales Co.
Joseph Dixon Crucible Co.
Modern Engineering Co.
National Carbon Co.
U. S. Welding Co.

WELDING ROD HOLDERS
Stoody Co.
C. Sorensen

There's No Waste Motion Here

YOU can undoubtedly reach a large number of good firms through an advertising campaign which is concentrated in papers reaching selected industries, and reach along with them thousands of readers who are not and never will be concerned with welding—that's waste. You pay a needlessly high price for the interest that's there, and you make a decidedly less effective impression on that interest than if you used a less expensive campaign in **The Welding Engineer,** which reaches the concentrated interest of the country. In these pages you talk to the **right man,** in the **right plant,** at the **right time.** That's efficiency.

Ask for a copy of "The Welding Industry"

The Welding Engineer 608 S. Dearborn St., Chicago

ALPHABETICAL INDEX TO ADVERTISERS

A
Acme Electric Welder Co..... 56
Air Reduction Sales Company....Front Cover
Allan Mfg. and Welding Co..... 58
The American Brass Co..... 39
American Welding Society..... 56
American Optical Co..... 49

B
Bastian-Blessing Co., The.....30-31
Bierman-Everett Fdy. Co..... 58
Buffalo Dental Mfg. Co..... 56

C
Central Steel & Wire Co..... 50
Chicago Steel & Wire Co..... 9
Chicago Eye Shield Co..... 58
Commercial Acetylene Supply Co..... 8
Alfred E. Corp..... 58
Wm. Cramp & Sons..... 51

D
Joseph Dixon Crucible Co..... 52
M. Keith Dunham..... 51

E
Elec. Arc Welding & Cutting Co..Back Cover

F
Fibre-Metal Products Co..... 48
Fibre-Metal Products Co..... 48

G
Gas Products Assn..... 10
General Electric Co..... 37
Griesheimer 53
Goodman Electric Mach. Co..... 58

H
Heylandt Sales Co..... 48
Hoxite Co. 48

I
Ideal Face Shield Co..... 54
International Oxygen Co.....
Imperial Brass Mfg. Co..... 58

K
Kerr's Welding School.....
K-G Welding & Cutting Co..... 56

L
Linde Air Products Co..... 18

M
Mattice Engineering Co., Inc..... 53
Metal and Thermit Corp.....
Milburn, Alexander, Co..... 57
Modern Engineering Co..... 54
Morey Flux and Chemical Co..... 58
Morris-Wheeler & Co., Inc..... 57

N
National Carbon Co..... 58
National Gauge and Equipment Co.....

O
Oxweld Acetylene Co..... 2

P
Page Steel & Wire Co..... 54
The Prest-O-Lite Co., Inc..... 35
The Purox Co..... 3

R
Reid-Avery Co..... 52
Roebling, John A., Sons Co..... 49
Rudolph, Wm. 56

S
Seneca Wire Mfg. Co..... 53
C. Sorenson 58
Shawinigan Products Corporation..... 55
Sherwood Mfg. Co..... 56
H. E. Steinbock..... 58
Steel Sales Corp..... 11
Stoody Co. 56-58
Straus & Bengeleisen..... 55
Superior Oxy-Acetylene Machine Co..... 57
N. A. Strand & Co..... 58

T
Torchweld Equipment Co..... 50
Todd Shipyards Corp. 15

U
Una Welding & Bonding Co..... 55
Union Carbide Sales Co..... 13
U. S. Gauge Co..... 56
United States Welding Co..... 57

W
Westinghouse Electric Mfg. Co.....4, 5
Wickwire-Spencer 48
Wilson Welder & Metals Co..... 6
Willson Goggles, Inc..... 53
Wodack Electric Tool Corporation..... 47

UNION CARBIDE

WORLD'S BEST QUALITY—HIGHEST GAS YIELD

ALWAYS PACKED IN BLUE AND GRAY DRUMS

Large Stocks of Union Carbide in all regular commercial sizes are carried at each of Union Carbide Sales Company's Warehouses listed below.

Requests for information and special correspondence should be addressed to our New York, Chicago or San Francisco offices.

Generator Sizes of Union Carbide

Packed in 100 Pound Drums

3½ in. x 2 in. (Lump)
2 in. x ½ in. (Egg)
1¼ in. x ⅜ in. (Nut)
¼ in. x 1/12 in. (Quarter)

For Oxy-Acetylene Welding and Cutting Plants, Acetylene House Lighting and Cooking Plants, Contractor's Torches and Flare Lights, and numerous other pieces of Acetylene generating apparatus designed for the use of one of these sizes of Carbide.

UNION CARBIDE SALES COMPANY

Peoples Gas Building
Chicago, Ill.

Carbide and Carbon Building
30 East 42nd St.
New York

Balfour Building
California and Sansome Sts.
San Francisco, Calif.

UNION CARBIDE SALES COMPANY'S WAREHOUSES

Shipments Always Made On Day Orders Are Received

ALABAMA
Birmingham....12 S. 20th St.
Mobile....16 S. Commerce St.
Montgomery....North Lawrence and Randolph Sts.

ARIZONA
Pheonix....42 S. Central Ave

ARKANSAS
Ft. Smith....201 Rogers Ave.
Little Rock....1400 E. 6th St.

CALIFORNIA
Fresno....932 H St.
Los Angeles....639 Gibbon St.
Oakland....See San Francisco
Sacramento....1717 Third St.
San Diego....301 Fourth St.
San Francisco....Balfour Bldg., 351 California St.
Stockton....748 S. Union St.
Taft....130 Center St.

COLORADO
Denver....Nineteenth and Wazee Sts.

CONNECTICUT
East Hartford....225 Prospect Ave.

DISTRICT OF COLUMBIA
Washington..New York and Florida Ave., N. E.

FLORIDA
Jacksonville....P. O. Box 124, 13 Cedar St.
Miami....P. O. Box 390, 91 N. E. 24th St.
Tampa....Ellamac Ave. and 13th St.

GEORGIA
Atlanta....Haynes and Rhodes St., P. O. Box 1594
Savannah....P. O. Box 78
Ogeechee Canal, Foot of Margaret St.

ILLINOIS
Chicago....122 S. Michigan Boulevard
Danville....511 Oak St.
Decatur....133 W. William St.
East St. Louis....700 Broadway
Eldorado....856 S. Fourth St.
Harrisburg....Jackson and Raymond Aves.
Marion....315 S. Granite St., P. O. Box 747
Monmouth....509 S. First St.
Peoria....100-110 Edmund St.
Quincy....313 Delaware St.
Springfield....1801 Washington St.
Streator....501 E. Hickory St.

INDIANA
Evansville....1401 E. Illinois St.
Fort Wayne....2206 Broadway
Indianapolis....330 W. New York St.
Terre Haute....541 N. Fifth St.

IOWA
Davenport....118 Harrison St.
Des Moines....Third and Elm Sts.
Dubuque....8th and Washington Sts.
Fort Dodge....Central Ave. at 16th St.
Ottumwa....207-9-11 S. Washington St.
Sioux City....410 Court St., P. O. Box 398
Waterloo....1209 E. Fourth St.

KANSAS
Pittsburgh....1201 North Broadway
Salina....154 N. Fifth St.
Wichita....600 W. Douglas Ave., P. O. Box 951

KENTUCKY
Lexington....Third St. and Walton Ave.
Louisville....Brook and Main Sts.
Middlesboro....1701 Cumberland Ave.

LOUISIANA
New Orleans....118 N. Front St.
Shreveport....615 Market St., P. O. Box 62

MAINE
Portland....48 Commercial St.

MARYLAND
Baltimore....19 E. Lombard St.
Cumberland....P. O. Box 172, 18 N. George St.
Sallisbury....Cor. Mill and Hight St.

MASSACHUSETTS
Indian Orchard....Pasco Road
Worcester....15 Federal St.

MICHIGAN
Detroit....5785 Hamilton Ave.
Grand Rapids....500 Shawmut Ave., N. W.
Hancock....First National Bank Bldg.
Iron Mountain....513 Stephenson Ave.
Iron River....321 Carnegie Ave., P. O. Box 357
Ironwood....
Ishpeming....511 E. Vine St.
Jackson....518 S. Water St.
Lansing....617 E. Shiawasee St.
Muskegon....301 W. Western Ave.
Saginaw....1830-1840 N. Michigan Ave.
Sault Ste. Marie....

MINNESOTA
Minneapolis....334 N. First St.
Virginia....413 Chestnut St.

MISSISSIPPI
Vicksburg....1701-03 Levee St., P. O. Box 322

MISSOURI
Kansas City....1422 St. Louis Ave.
St. Joseph....920 S. Sixth St.
St. Louis....(See East St. Louis, Ill.)

NEBRASKA
Omaha....1007-9-11 Jones St.

NEW JERSEY
Camden....Front and Division Sts.
Newark....251-255 Ridgewood Ave.

NEW YORK
Albany....108 Third Ave.
Binghamton....85 Prospect Ave.
Buffalo....1345 Genesee St.
Garden City....Near Clinton Road Sts.
Geneva....261 Exchange St.
Hurleyville....
Kingston....O'Neil St., Near Broadway
Niagara Falls....
Poughkeepsie....Smith St. and C. N. E. R. R.
Utica....135 Hotel St.
Watertown....438 Court St.
Whitehall....57-59 Main St.

NORTH CAROLINA
Charlotte....205 W. First St., P. O. Box 777
Raleigh—P. O. Box 149, McCullough and Lenoir Sts.
Wilmington....612 Surry St.
Wilson....700 S. Goldsboro St.

NORTH DAKOTA
Fargo....Fifth St. and Second Ave., N.

OHIO
Akron....97 East South St.
Athens....Corner Factory and Moore Sts.

Canton....618 Mulberry Road, S. E.
Cincinnati....67 Plum St.
Cleveland....1348 Hanna Bldg., Annex
Columbus....330 Dublin Ave.
Dayton....104-114 S. Wayne Ave.
Gallipolis....700 First Ave.
Lima....338 E. High St.
Mansfield....40 W. Third St.
Steubenville....324 N. Seventh St.
Toledo....414 S. Erie St.
Youngstown....Jones and Brittain Sts.
Zanesville....Main and 2nd Sts.

OKLAHOMA
McAlester....127 East Chickasaw St.
Oklahoma....4 West Park Place
Tulsa....1-11 N. Boulder St.

OREGON
Portland....15th and Hoyt Sts.

PENNSYLVANIA
Allentown....311 Gordon St.
Beaver....244 Buffalo St.
DuBois....Weber Ave. and Franklin St.
Erie....1502 Sassafras St.
Greensburg....Clark and George Sts.
Harrisburg....25 S. Tenth St.
Hazelton....223 East Mine St.
Johnstown....Messenger St. and B. & O. R. R.
Philadelphia....Delaware Ave and Brown St.
Phillipsburg....P. O. Box 146, North Front St.
Pittsburgh....1202 Chamber of Commerce Bldg.
Pottsville....Railroad and Sanderson St.
Scranton....225 Vine St.
Shamokin....Fifth and Walnut Sts.
Sharon....Budd St. and South Irvine Ave.
Spangler....Bigler Ave.
Wilkes-Barre....150-156 E. Northampton St.
Williamsport....Canal and Court Sts.

SOUTH CAROLINA
Charleston....3 Liberty St.

SOUTH DAKOTA
Watertown....224 First Ave., N. W.

TENNESSEE
Chattanooga....522 E. 10th St.
Knoxville....426 West Depot Ave.
Memphis....671 S. Main St.
Nashville....102-104-108 Broadway

TEXAS
Amarillo....P. O. Box 697, 101-105 Pierce St.
Beaumont..Santa Fe Bldg., 1118-28 Jackson St.
Dallas....Santa Fe Bldg., 1118-28 Jackson St.
El Paso....First and Kansas Sts., P. O. Box 103
Houston....812 Live Oak St.
San Antonio....115 S. Medina St.
Waco....315 S. Thirteenth St.
Wichita Falls....1507 Lamar St., P. O. Box 1002

UTAH
Salt Lake City....108 W. Second South St.

VIRGINIA
Lynchburg....1324 Commerce St.
Norfolk....120 W. Plume St.
Richmond....1709 East Cary St.

WEST VIRGINIA
Bluefield....195 Roanoke St.
Charleston....Broad St. and K. & M. R. R.
Clarkesburg....608 North Third St., P. O. Box 503
Elkins....Railroad Ave and First St.
Fairmont....Auburn St. and B. & O. R. R.
Huntington....Seventh Ave. and Elm St.
Morgantown....610 University Ave.
Mount Hope....P. O. Box 416
Mullens....P. O. Box 37
Wheeling....43rd and McCulloch Sts.
Williamson....P. O. Drawer 305

WASHINGTON
Seattle....304 Railroad Ave., S.
Spokane....162 S. Post St.

WISCONSIN
Appleton....909 N. Lawe St.
La Crosse....Front and King Sts.
Madison....513-19 Williamson St.
Marshfield....South Dept. and Maple Sts.
Milwaukee....120 Jefferson St.

WYOMING
Casper....222 Industrial Ave.
Oakland....See San Francisco

UNION CARBIDE IS EASILY OBTAINABLE EVERYWHERE

The right foundation for good cutting and welding is pure Acetylene

We supply it in:

Carload lots, truckloads or single cylinders.

Whatever your acetylene gas requirements may be let us quote you. Outline your gas consumption and our prices will be promptly furnished.

Supplied in the following size cylinders:

10x30in. size	- -	125 cu. ft. capacity
12x36in. size	- -	225 cu. ft. capacity
12x44in. size	- -	275 cu. ft. capacity

COMMERCIAL ACETYLENE

Means pure acetylene.

COMMERCIAL SERVICE

Means prompt service.

No matter what your gas requirements are you will be interested in our sales plan.
Ask our nearest office to tell you about it.

Commercial Acetylene Supply Company, Inc.

General Office: 80 Broadway, New York City

Branches:

80 E. Jackson Blvd.
Chicago, Ill.

421 Trust Co. of Georgia Bldg.
Atlanta, Ga.

683 Atlantic Ave.
Boston, Mass.

550 Monadnock Bldg.
San Francisco, Calif.

New Welding Rod Facts

This Booklet

Tells for the first time the scientific facts concerning Welding Rod. It answers in plain language literally hundreds of questions for the welder.

Do you know---

Why sulphur segregated to the center of a rod does no harm but if distributed throughout the rod causes poor welds?

That water under some conditions will ruin a welding rod?

Where gas gets into a welding rod and what its presence means to the welder?

How carbon and manganese affect an electrode?

What the real difference is between gas and electric rod?

Why some welding rod is no better than fence wire and some fence wire makes good welding rod?

Every user has at sometime had Filler Rod trouble which he did not understand. The answer is in this booklet.

Free for the asking

In addition to the text there is a Catalog Section

This describes the WELDITE Line of Iron or Steel Filler Rods. It includes five different grades of steel rod for gas welding and five for electric welding. These range from practically pure iron to the very highest carbon. It also includes a wonderful nickel steel and a special Chrome-Vanadium Rod for track work.

Ask to have your name on the list to receive all the bulletins published by the Research Department of the

Chicago Steel & Wire Co.

103rd Street & Torrence Avenue :: Chicago, Ill.

Everybody is helped— everybody should help!

TUBERCULOSIS in this country is a threat against your health and that of your family. There are more than a million cases in this country today.

The germs from a single case of tuberculosis can infect whole families. No one is immune. The only sure escape is to stamp out the dread disease entirely. It can be stamped out. The organized work of the tuberculosis crusade has already cut the tuberculosis death rate in half. This work is financed by the sale of Christmas Seals.

Everybody is helped by this great work — and everybody should help in it. Let every member of your family stamp all Christmas parcels, letters and greeting cards with these able little warriors against disease. Everybody, everywhere, buy Christmas Seals — and buy as many as you can.

Stamp Out Tuberculosis with this Christmas Seal

THE NATIONAL, STATE, AND LOCAL TUBERCULOSIS ASSOCIATIONS OF THE UNITED STATES

A Welding Rod for Every Use

In Acetylene and Electric Welding

You will find a welding rod for every use, in acetylene and electric welding, carried in our Chicago stocks for immediate shipment. A few important kinds are mentioned below. Testing samples sent free.

Norweld Special—*Acetylene*
Copper coated, exceptionally low in carbon, phosphorus and sulphur. Conforms to A.W S. Spec. G. No. 1-A. Should be used when welding galvanized and high pressure tanks, sheets or wherever maximum ductility and non-porous welds are required.

Norweld—*Acetylene*
Slightly higher in carbon than Norweld Special, Copper coated, soft, uniform in quality. Recommended for welding of wrought iron, steel, tanks, boiler plate, sheets, angles, flues, etc. where higher tensile strength is required.

Castweld—*Acetylene*
Made of the highest grade Virgin Pig Iron. Contains over 3% silicon, extremely low in manganese, phosphorus and sulphur. Of correct analysis to produce soft machineable welds.

A Practical Book on Welding

Describing Our Complete Line of Rods

Bronzeweld—*Acetylene*
A drawn Tobin Bronze rod for welding bronze or brass and brazing malleable iron or steel parts.

Nickelweld—*Acetylene and Electric*
A special nickel steel; composition so balanced as to produce maximum strength and high ductility. Recommended for welding cold rolled shafting, nickel and chrome steels, crank shafts, axles, frames and all parts subjected to excessive strains. **Flux Coated if desired.**

Elecweld Special—*Electric*
A very low carbon bare wire, medium hard and soft, very low in phosphorus and sulphur. Especially treated in our plant to improve its welding properties. Conforms to A. W. S. Spec. E. No. 1-A. **Furnished flux coated when desired.** Recommended to produce maximum ductility and non-porosity.

Elecweld—*Electric*
Slightly higher in carbon than Elecweld Special. Conforming to A. W. S. Spec. E. No. 1-B. Recommended where high tensile strength is required. **Flux coated when desired.**

Steelweld—*Electric*
A mild steel, plain finished rod, usually furnished in larger sizes in 36 inch lengths. Particularly suited for welding steel castings with the carbon arc.

Wilson Color-tipt Metals—*Electric*
A rod for every need in metallic arc welding. Well known for their exceptionally high quality. Results of exhaustive experiments to produce proper flowing qualities, penetration and sound mechanical welds. Ends of each rod are colored to identify grades. Packed in 5 lb. bundles, 20 bundles in a case. Send for Bulletin No. 100.

MAIL THE COUPON FOR SAMPLES

STEEL SALES CORPORATION

CORPORATION

129 South Jefferson Street
CHICAGO, ILL.
Telephone, Franklin 4280

J. A. Roesch, Jr., *President* F. W Walters, *Vice-President*
D. R. Hoffman, *Secretary and Treasurer*

Steel, Monel Metal, Nickel, Brass, Copper, Nickel Silver, Phosphor Bronze, Wire Rope

STEEL SALES CORPORATION, 129 S. Jefferson St., Chicago

Gentlemen:
Please send me a sample of the following rods mentioned in THE WELDING ENGINEER.

I do— ☐ Elec. ☐ A. C. ☐ D. C. ☐ Acety. Welding

Firm.....

Street.....

City..... *State*.....

"NATWELD"

Duo-Fold Safety Oxygen Gauge

Patented

Mechanically Perfect

Safety Accuracy Durability

UNCONDITIONALLY WARRANTED

And What's More—The Price Is Right!

NATIONAL GAUGE & EQUIPMENT COMPANY

WORLD'S LARGEST MANUFACTURERS OF BOURDON SPRING GAUGES

MAIN OFFICE AND FACTORIES—LA CROSSE, WISCONSIN

CHICAGO DISTRICT
JOSEPH HALLA
140 S. Dearborn Street

DETROIT DISTRICT
P. E. STROUP
1208 Kresge Bldg.

NEW YORK DISTRICT
H. T. OWENS
51 East 42nd Street

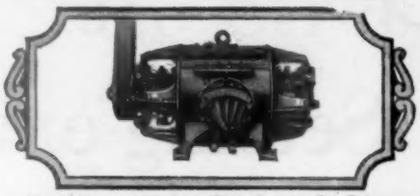
Let This Todd Welder Save You $7,000

WHICH will you have for welding purposes—seven machines to suit seven different needed welding requirements—or the Todd Welder that will meet all needs?

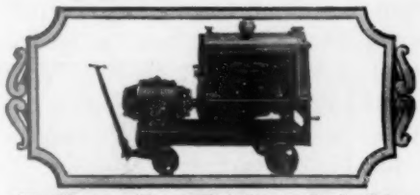
For example, a machine each for the following requirements of 110 volts D.C.; 220 volts D.C.; 550 volts D.C.; 220 volts, 60 Cycle, 2 Phase A.C.; 220 volts, 60 Cycle, 3 Phase A.C.; 440 volts, 60 Cycle, 2 Phase A.C.; 440 volts, 60 Cycle, 3 Phase A.C. would mean an expenditure approximating $7,000. Yet one Todd Twin Pole Arc Welder, gasoline driven, will meet all welding requirements at one initial outlay.

This Todd Welder can be driven from the power take-off of a Fordson engine or any other suitable gas engine or can be belt driven. Power is also supplied for operating electric drills, grinders, chippers, lights and other purposes without interfering with the welding circuit. These Todd Welders are furnished in two types for field work, ER and ER2—and are recommended for use as part of a Fordson. Write us for complete information.

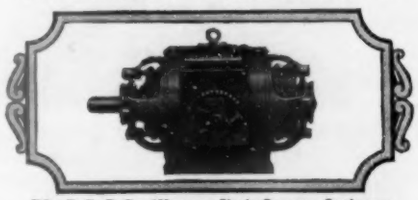
TODD TWIN POLE ARC WELDERS
25 Broadway, New York City



ER—1200 r.p.m.—200 amp.—Single Operator Belt Drives
Length, 33 5-8 inches Diameter, 16 1-8 inches
Net weight, 611 pounds Shipping weight, 680 pounds

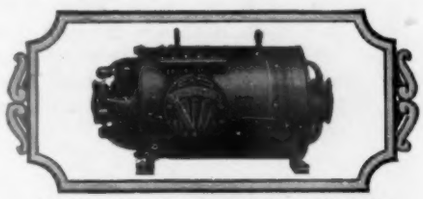


ER—1200 r.p.m.—150 amp.—Single Operator Gasoline Drive
Length, 74 inches Width, 39 inches Height, 60 inches
Net weight, 2475 pounds Shipping weight, 2775 pounds

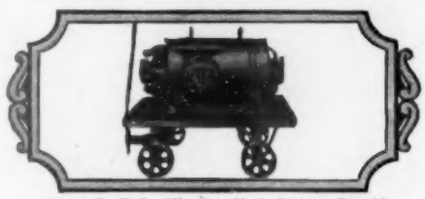


DR—D.C. D.C.—150 amp.—Single Operator Stationary
Length, 33 5-8 inches Diameter, 16 1-8 inches
Net weight, 611 pounds Shipping weight, 680 pounds

DR2—D.C. D.C.—200 amp.—Single Operator Stationary
Length, 35 1-8 inches Diameter, 16 7-8 inches
Net weight, 650 pounds Shipping weight, 710 pounds



AR—A.C. D.C.—200 amp.—Single Operator Stationary
Length, 38 inches Diameter, 17 1-8 inches
Net weight, 765 pounds Shipping weight, 840 pounds



AR—A.C. D.C.—200 amp.—Single Operator Portable
Length, 36 inches Width, 24 inches Height, 12 inches
Net weight, 880 pounds Shipping weight, 955 pounds

TODD
NEW YORK, U.S.A.

Setting exact standards for the oxy-acetylene process

The Union Carbide and Carbon Research Laboratories, Inc., occupies almost a city block of floor space in this large building in Long Island City. Floor space, however, means little in a research laboratory if men and equipment are lacking. The equipment is as complete as that of any laboratory in the United States and the caliber of men is indicated by the fact that one of chemistry's most coveted prizes—the Perkin Medal—was recently awarded to one of the staff.

THE Union Carbide and Carbon Research Laboratories, Inc., at Long Island City, is really manufacturing standards for the oxy-acetylene process.

New applications of the process usually originate in the field. They could be developed by the trial and error method and passed from one welder to another by rule of thumb instruction.

The Linde Company, however, submits such new applications to its research laboratory. Here, not only is the weld tested, but the correct procedure worked out so that it is metallurgically sound. Applications perfected in the Linde laboratory work—not occasionally, but *every time.*

Every technical factor in oxy-acetylene welding and cutting is tested and checked by the laboratory. Furthermore, the laboratory furnishes Linde engineers with data sufficient to satisfy the most exacting demand for technical information.

This research laboratory is a part of Linde Process Service which is free to Linde customers for the asking.

THE LINDE AIR PRODUCTS CO.

General Offices:
Carbide and Carbon Building, 30 E. 42d Street
New York, N.Y.

37 Plants *22 District Sales Offices* *91 Warehouses*

LINDE OXYGEN

YOU CAN DEPEND ON THE LINDE COMPANY

Cutting Cast Iron on State Street

Oxy-Acetylene Torch Makes a Smooth and Economical Job of Taking a Slice from an Old Store Front

CHICAGO crowds are becoming accustomed to the spectacular performance of the oxy-acetylene cutting torch because there is so much construction work always in progress in the downtown district and the cutting outfit is practically an indispensable tool around every important construction job. The same thing, of course, applies to demolition jobs. The operation is always an interesting one to the spectators most of whom do not realize the capacity of the comparatively small instrument for separating iron and steel members of almost any size.

It is interesting to join a crowd of men who are watching some of these cutting operations and hear the learned explanations of the operation of the torch and the great variety of ways they can find for pronouncing oxy-acetylene. A salesman can add quite a bit to his store of selling talk if he can believe some of the statements made concerning the process by these disinterested onlookers.

Nearly always the operation in question is a steel cutting job but a short time ago a cutting torch operator put on an exhibition of cast iron cutting for the benefit of State Street crowds and the results of the work are illustrated in the accompanying photographs. The building shown in the photographs adjoins the former site of the building occupied by the Singer Sewing Machine Company in the heart of the loop district of Chicago on State Street. A fire having destroyed the Singer Building it became necessary to clear away the ruins preparatory to the erection of a new building on that location. Then it was found that the front of the building shown here was made up of a series of iron castings and that this front extended about eight inches south of the extreme edge of the wall of the building. Therefore, in making preparations for the construction of the new building it became necessary to trim off eight inches from the store front.

The wrecking work was done by the Newman Company, one of the best known firms of the line of business in Chicago. This company has had a wide experience and whenever their jobs call for the use of the oxy-acetylene cutting process they have called upon the Louis Tatter Welding Company to do the cutting as special contractors. Several years ago these people might have shaken their heads at the idea of using the cutting torch on cast iron but they have kept in touch with the developments in the industry and when the call came for this work on cast iron they were prepared to handle it. One of the photographs in the group shown here is a close-up of the bottom of the cut and a glance at it will

Left—How Cutting Was Done—Center—Close-up of Cut. Right—The Finished Job.

answer all questions regarding the quality of the workmanship on this particular job. The thickest part of the casting was approximately 1½ inches while the thinnest part was about ⅜ inch thick. According to Mr. Tatter the thinnest part gave the most trouble because it was in the form of a fancy molding, this you can see in the picture, and also because the iron was very impure. This resulted in the consumption of a great deal more time than would have been the case otherwise. Weather conditions were not of the best as it was rainy, drizzly weather, this coupled with the heavy paint, the impure iron, and the faulty construction of the building, which allowed several small fires to start, made the task a rather difficult one running the time required up to six days. It was necessary to exercise considerable ingenuity in order to provide comfortable working conditions. As shown in the photographs, a platform was swung from the top of the building and gradually lowered as the cutting progressed from the top to the bottom. There was a generous margin allowed so the operator in making the cut was able to use the extreme edge of the brick work for his guide instead of following a chalk mark for the heat of the torch made the heavy paint peel and destroy the chalk mark. Working under these conditions, the straightness and cleanness of the cut was a very creditable job, although a little more time was consumed. The operator used an ordinary Milburn cutting torch with the ordinary cutting tip and one Oxweld C-6 cutting torch. The work required more gas than if it had been a steel job but they were able to carry it on to the complete satisfaction of the contractors, especially since this trimming operation on the building was completed at a far lower cost than it could have been done by any other method. The amount of gas consumed on this cutting job amounted to sixteen drums of oxygen and five drums of acetylene. The length of cut was approximately 75 to 85 feet. The amount of cast iron which was cut away from this party wall was sold by the builder for $90.00 and from this amount you can readily see that there must have been quite heavy pieces and a good heap of cast iron for a junk man to offer this price without first weighing the material. Curious readers can figure out what the tonnage might have been by looking up the market price of cast iron. Mr. Tatter estimates that there must have been at least twelve tons of cast iron cut away. This was anchored from the back right into the brick wall on each floor making the column appear as in the form of a "U" shape.

The increased gas consumption in cutting cast iron as compared to the cutting of steel is due to the fact that the heating flame usually carries an excess of acetylene and that cast iron requires a longer period of preheating. It is also necessary to use a semi-circular movement of the torch tip which slows up the forward progress and makes a wider kerf. The operator usually does not try to make as smooth and straight a cut as he would on a steel job of the same thickness but when it is absolutely necessary an expert operator can produce a cut surface which compares very favorably with ordinary cuts made on steel.

As previously stated the cut began at the top. The operator cut the cast iron down about one-third of the distance between the top floors. He then cut out to the edge and the piece of cast iron was removed. The next cut went down to the next floor before he cut to the outside and from then on only two outward cuts were made to a floor. Before the work was commenced the operator had thought that it would be necessary to cut the casting into small pieces and everyone concerned was pleased to find that fewer cuts were necessary.

PROMINENT WELDING ENGINEERS KILLED IN TRAIN CRASH

The following members of the Inter-Factory Welding Committee of the General Electric Company were killed in the crash of the Pennsylvania-St. Louis flyer and the Washington Express at Monmouth Junction, New Jersey, shortly after six a. m. Thursday, Nov. 12. M. A. Atuesta, chairman; J. C. Horstman; R. D. Reid, and A. W. Gross, of Schenectady (G. E.) plant.

Another member of this committee was seriously injured. Thomas Wry, of Lynn, Mass., Works, but is expected to recover.

The sixth member of the committee, D. H. Deyoe, escaped with merely a blackened eye.

The committee's function was to visit the various G. E. factories and recommend welding procedure to be followed. They were en route from the Baltimore plant to the Bloomfield, N. J., plant.

R. D. Reed was practically head of the G. E. Arc Welding Dept. and his loss will be keenly felt. Mr. Wry conducted the Boston show.

Both were members and officers of the American Welding Society.

SHERWOOD HIGH PRESSURE CYLINDER VALVES

A high pressure cylinder valve for oxygen, hydrogen, carbon-dioxide, argon, helium, etc., is being offered to the compressed gas industry by the Sherwood Manufacturing Company of Buffalo, N. Y. The manufacturers claim unusual durability in these valves and, at the same time, emphasize the case of opening them. In operation, they say, there is no sticking or distortion of internal parts. The Sherwood Company has been making valves for this service for something like twenty years.

NEW CLEVELAND OFFICE FOR WELDITE

The Chicago Steel and Wire Company is now opening up a branch office in Cleveland, Ohio. It will be in charge of Mr. R. R. Applegate who conducted numerous welding tests for the United States Navy and who for a time was connected with the Rail Welding and Bonding Company of Cleveland as an engineer. Mr. Applegate will have an office at Room 305, Euclid-61st Building in Cleveland and he will also have a warehouse stock of Weldite rods on hand in order to give the best possible service.

"We feel that with Mr. Applegate's experience in the welding field, we will be able to serve the Cleveland district in very good shape," states F. B. Toombs, general sales manager of the concern.

Chromium Molybdenum Welding Wire[1]

Possibilities of Using This Wire for Gas Welding of Steel Tubing and Sheet in Aeroplane Construction

By F. T. Sisco and H. W. Boulton

IN the construction of the modern airplane, the framework of the fuselage is seamless steel tubing. The longerons (horizontal members) which extend from nose to tail are braced at intervals by diagonals of seamless tubing welded to them. In the construction of these various welded members making up the fuselage, two main factors enters: (1) materials; and (2) workmanship. By employing skillful and experienced welders the second factor may be made practically constant. The work outlined in the present paper was done to investigate the possiblity of effecting an improvement in the materials and included a study of the various kinds of materials and their properties after welding. The effect of heat treatment on the physical properties of the welded tubes and sheet and on the structure of the weld was also investigated.

While it was originally planned to confine the welding experiments to seamless tube only, it was thought advisable to make at the same time a study of welded chromium-vanadium steel sheet.

Table I
Analyses of Materials

	C	Mn	S	P	Cr	Mo	V
Chromium-molybdenum steel tube	0.32	0.56			0.93	0.23	
Medium carbon steel tube	0.31	0.45	0.038	0.040			
Low carbon steel tube	0.18	0.49	0.030	0.040			
Chromium-vanadium steel sheet	0.14	0.50	0.028	0.040	0.77		0.23
Low carbon welding wire	0.03	0.48					
Cromium-molybdenum steel welding wire	0.28	0.61			1.14	0.95	

Note—Phosphorus percentages all below 0.040 per cent.

Although the results obtained by this investigation cannot be called complete and conclusive, enough was accomplished to show that welding with chromium-molybdenium wire could be done successfully on a commercial scale, and to indicate that in some cases such welds should give better service than welds made with regular low carbon wire.

Chromium-molybdenum steel in the form of wire suitable for welding is not available at the present time. The wire used in this investigation was supplied through the kindness of the Air Reduction Company, Jersey City, N. J., who make up a small coil for use in these experiments.

Material

The material used in this investigation included three grades of seamless steel tubing and one grade of sheet stock. The composition of the material, together with the analyses of the two grades of welding wire, are shown in Table I.

Tubing and sheet of only one size is used. The former was cold drawn seamless tubing 1 inch in outside diameter and 0.036 inch wall. The sheet was 0.036 inch in thickness. The low carbon and the chromium-molybdenium steel welding wire were both $\frac{1}{16}$ inch in diameter.

The low carbon steel welding wire was copper-coated and was taken from the welder's stock. The chromium-molybdenum steel wire was uncoated. Both grades of wire were soft drawn, that is, they had probably been given one draft after annealing. The physical properties of the two grades of wire are given in Table II.

Table II
Physical Properties of Welding Wire

Welding Wire	Low Carbon	Copper-Coated	Chromium-Molybdenum	Uncoated
Class Designation	A		B	
Specimen No.	1	2	1	2
Gage length, in.	10	10	10	10
Diameter, in.	0.062	0.062	0.062	0.062
Ultimate Strength, lbs. per sq. in.	57,350	67,150	118,000	116,700
Elongation in 10 in., per cent	3.6	1.6	1.6	2.1
Fracture	Cup	Cup	Cup	Cup

The chromium-molybdenum steel tubing was in the normalized condition. The chromium-vanadium steel sheet was furnace annealed. The three grades of tubing and the sheet were from stock purchased under Air Service Specifications. The physical properties of the material as received conformed in every case to the requirements noted in Table III.

Table III
Required Physical Properties of Steel Tubing and Sheet
(Air Service Specifications)

	Tensile Strength, minimum, lbs. per sq. in.	Yield Point, minimum, lbs. per sq. in.	Elongation in 2 in., per cent
Chromium-molybdenum steel tubing	95,000	60,000	....
Medium carbon steel tubing	80,000	60,000	18
Low carbon steel tubing	55,000	36,000	22
Chromium-vanadium steel sheet		Not specified	

Note—Tubes are required to pass a crushing test without failure. Sheet is required to pass a 180-degree bend over a radius equal to thickness of sheet without cracking.

It was desired to have the chromium-molybdenum steel welding wire of the same composition as the tubes. However, the wire furnished contained 0.95 instead of 0.25 per cent molybdenum and as no other chromium-molybdenum steel wire could be obtained the work was done with the material available.

Method of Procedure

The method of procedure in carrying on the work was divided into four parts. They are:

1. Welding the tubes and sheet
2. Heat treatment
3. Physical tests
4. Metallography.

Welding

In preparation for welding, the tubes were cut into 8-inch lengths and one end squared up on a lathe. The sheet was cut into 1-inch strips, 6 inches long and similarly machined on one end. As the chromium-molybdenum steel wire was not in the proper condition for arc welding, the welds were all made by the oxy-acetylene torch. No special precautions were taken. The work was done in identically the same manner as production- and repair-welding on fuselage construction. The operator who did the welding was exceptionally skillful and in every case produced welds of perfect workmanship.

The welding procedure with the class and letter designation was as follows:

Schedule I—Not to Be Heat Treated

Tube Welding

Class 1

A—Chromium-molybdenum steel tube welded to chromium-molybdenum steel tube, using low carbon steel welding wire.

B—Same as A, but using chromium-molybdenum steel welding wire.

Class 2

A—Chromium-molybdenum steel tube welded to medium carbon steel tube, using low carbon steel welding wire.

B—Same as A, but using chromium-molybdenum steel welding wire.

[1] *Published by permission of the Chief of Air Service, War Department.*

Of the authors, F. T. Sisco is metallurgist and H. W. Boulton is test engineer, Engineering Division, Air Service, War Department, McCook Field, Dayton, Ohio.

Reproduced from Transactions of the American Society for Steel Treating by courtesy of the Society.

Class 3

A—Chromium-molybdenum steel tube welded to low carbon steel tube, using low carbon steel welding wire.

B—Same as A but using chromium-molybdenum steel welding wire.

Sheet Welding

Class 4

A—Chromium-vanadium steel sheet welded to chromium-vanadium steel sheet, using low carbon steel welding wire.

B—Same as A but using chromium-molybdenum steel welding wire.

In Class 1 above, nine welds of A and nine welds of B were made. In Classes 2, 3 and 4 three welds of A and three welds of B were made.

Schedule II—To Be Heat Treated

Tube Welding

Classes 11, 12, 13

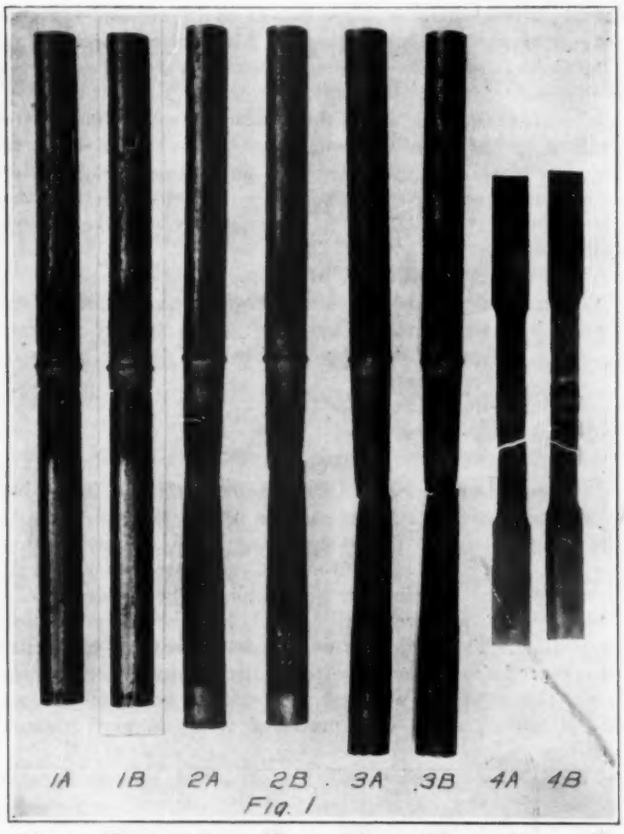
Chromium-molybdenum tube welded to chromium-molybdenum tube, using chromium-molybdenum welding wire.

Sheet Welding

Classes 14, 15

Chromium-vanadium steel sheet welded to chromium-vanadium steel sheet, using chromium-molybdenum steel welding wire.

In Classes 11, 12 and 13 six welds of each were made. In Classes 14 and 15 ten welds of each were made.



1A	1B	2A	2B	3A	3B	4A	4B
Cr-Mo. Tube welded to Cr-Mo. Tube	Cr-Mo. Tube welded to Cr-Mo. Tube	Cr-Mo. Tube welded to 1035 Tube	Cr-Mo. Tube welded to 1035 Tube	Cr-Mo. Tube welded to 1015 Tube	Cr-Mo. Tube welded to 1015 Tube	Cr-V. Sheet welded to Cr-V. Sheet	Cr-V. Sheet welded to Cr-V. Sheet
Low Carbon Welding Wire	Cr-Mo. Welding Wire	Low Carbon Welding Wire	Cr-Mo Welding Wire	Low Carbon Welding Wire	Cr-Mo. Welding Wire	Low Carbon Welding Wire	Cr-Mo. Welding Wire

Fig. 1—Location and Appearance of Fractures of Welded Chromium-Molybdenum and Carbon Tubing, and Chromium-Vanadium Sheet—Not Heat Treated

In addition to the welding outlined above, in which the walls of the tubes were all 0.036 inch, two 8-inch sections of chromium-molybdenum steel tubing with a ⅛-inch wall, were welded with chromium-molybdenum steel wire and two with low carbon steel welding wire. The welding procedure differed in this case in that the squared ends of the tubes to be welded were first beveled at an angle of 45 degrees before welding. The two welds of the heavy walled tubing were made to serve as a check on hardness results. It was desired to determine the Rockwell hardness values of the tubes in the vicinity of the weld, and it was considered probable that due to the thinness of section in the tube with an 0.036 inch wall erratic tests might result. In case errors in hardness tests became apparent, the thick walled tubes could be used as a check.

Heat Treatment

As the time available in investigating the welding of tubes and sheet was limited, it was necessary to confine the heat treatment to chromium-molybdenum steel tubes welded to chromium-molybdenum steel tubes using chromium-molybdenum steel welding wire only, and to chromium-vanadium steel sheet welded to chromium-vanadium steel sheet in a like manner. The chief purpose in heat treating the welded material was to eliminate the soft area discovered near the weld in the untreated specimens of the same class and to equalize the grain structure at and near the weld. The improvement of strength and ductility which resulted from heat treatment, while important, is not so essential as uniformity of properties and the elimination of any spots of weakness caused by local overheating in welding.

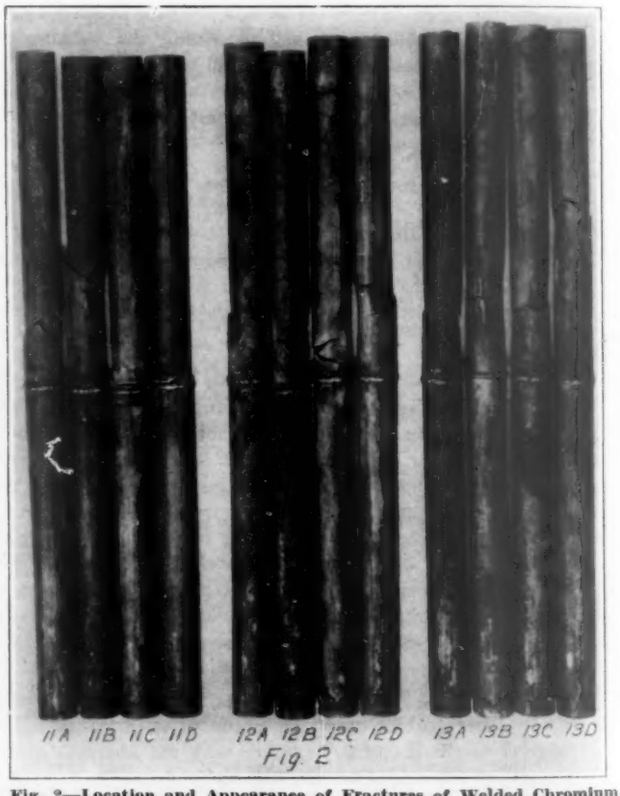


Fig. 2—Location and Appearance of Fractures of Welded Chromium-Molybdenum Tubing—Heat Treated. These Welds Are Chromium-Molybdenum Tubes Welded to Chromium-Molybdenum Tubes with Chromium-Molybdenum Wire. All Tubes were heated to 1625 Degrees Fahr. for 30 minutes and Quenched in Water. Groups 11A to 11D were Tempered at 800 Degrees Fahr. Groups 12A to 12D Were Tempered at 1000 Degrees Fahr. Groups 13A to 13D Were Tempered at 1250 Degrees Fahr.

The tubes and sheet welded according to Schedule II were heat treated in the following manner:

Class 11—Tubes

Heated to 1625 degrees Fahr. (885 degrees Cent.), held 30 minutes, quenched in water. Tempered at 800 degrees Fahr. (425 degrees Cent.) for 30 minutes and cooled in air.

Class 12—Tubes

Quenched as in Class 11, tempered at 1000 degrees Fahr. (540 degrees Cent.) for 30 minutes and cooled in air.

Class 13—Tubes

Quenched as in Class 11, tempered at 1250 degrees Fahr. (680 degrees Cent.) for 30 minutes and cooled in air.

Class 14—Sheet

Heated to 1625 degrees Fahr. (885 degrees Cent.), held 30 minutes, quenched in water. Tempered at 1000 degrees Fahr. (540 degrees Cent.) for 30 minutes and cooled in air.

Class 15—Sheet

Quenched as in Class 14, tempered at 1250 degrees Fahr. (680 degrees Cent.) for 30 minutes and cooled in air.

In heating for quenching and drawing, an electric muffle furnace was used. The temperature was controlled to 10 degrees Fahr. by a recording potentiometer and automatic current regulators. The tubes and sheet of each class were wired into bundles and placed in the furnace when the temperature was about 1300 degrees Fahr. Heating to 1625 degrees Fahr. was accomplished in about one hour; the material was then held 30 minutes at this temperature. The water for quenching was approximately 60 degrees Fahr. Each bundle of tubes and sheet was quenched *in toto*, thus insuring the same rate of heat extraction in each piece of the same class.

Physical Tests and Hardness

The tubes and sheet were tested in tension with a 20,000-pound tensile testing machine. The tubes were not machined but were held by friction grips after plugging each end with a tight fitting steel plug. The sheet specimens were machined to ½-inch, as shown in Fig. 3. This was done to be certain that the strip would not fracture in the grip.

Both tubes and sheet were punch-marked for taking elongation on a 2, 4, and 8 inch gage length. The proportional limit was taken with a Berry strain gage reading to 0.0002 inch. It was not necessary to take the proportional limit on all specimens. Those samples on which the proportional limit was not taken were tested for yield point. This was taken when the specimen elongated 0.01 inch in a gage length of 2 inches.

The proportional limit was taken from the stress-strain curve in which load in pounds was plotted against deflection in ten thousandths of an inch. The proportional limit was that point at which the curve first departed from a straight line, where deflection was no longer directly proportional to the load.

Due to the thinness of section of the tubes, Rockwell hardness tests were the only accurate values possible. These were taken at ⅛-inch intervals, beginning at the weld and extending 1½ inches to the right and to the left. These tests were made only to detect possible differences in hardness and thus determine if the heating that the tube had undergone in welding had caused local hardening or softening in the vicinity of the weld. Hardness tests were made only on chromium-molybdenum steel tube welded to chromium-molybdenum steel tube Classes 1A and 1B and Class 12. One specimen of chromium-molybdenum steel tube welded to chromium-molybdenum steel tube with chromium-molybdenum steel wire was tested for Rockwell hardness as quenched but not tempered.

In making the Rockwell hardness tests, the ⅛-inch ball and the B scale were used on the untreated tubes (Table IX). For the heat treated tubes the diamond point and C scale were used.

Metallography

Specimens for microscopic examination were cut longitudinally through the weld, including the weld and about ¼-inch of the tube on both sides. Specimens to show the normal structure of the steel were taken also longitudinally near the end of the tube or sheet and at least 6 inches from the weld. The specimens were all mounted in soft solder and were polished successively on an emery grinding belt and on 0, 00, and 000 French emery paper. Finish polishing was with levigated alumina on English "kitten ear" broadcloth. The specimens were examined unetched to detect the presence of any slag or other inclusions, and to note any unsoundness or oxidation in and around the weld. After this examination, the specimens were etched in alcoholic nitric acid (2 per cent). Representative photomicrographs were taken at magnifications of 100 and 500 diameters.

Results

The results of the work may be summarized under four heads:

(1) Welding
(2) Physical properties
(3) Uniformity of hardness near the weld
(4) Metallography

Welding

All of the welds made were perfect. This was due primarily to the skill of the welder. It was observed that the chromium-molybdenum steel welding wire did not flow so readily under the torch as the regular low carbon steel

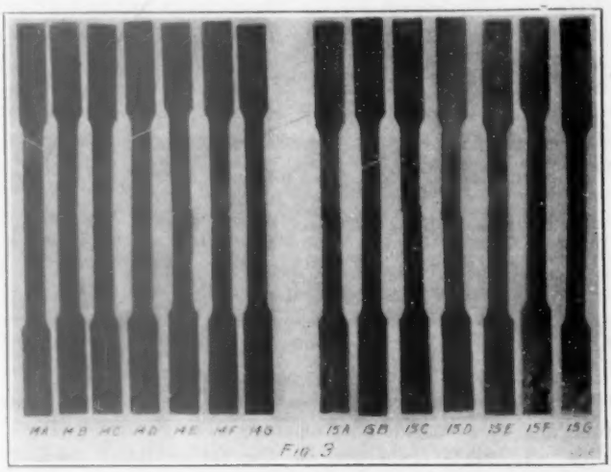


Fig. 3—Location and Appearance of Fractures of Welded Chromium-Vanadium Sheet—Heat Treated. These Welds Are Chromium-Vanadium Sheet Welded to Chromium-Vanadium Sheet with Chromium-Molybdenum Welding Wire. All Specimens Were Heated to 1625 Degrees Fahr. and Quenched in Water. Groups 14A to 14G Were Tempered at 1000 Degrees Fahr. Groups 15A to 15G Were Tempered at 1250 Degrees Fahr.

welding wire. The welder expressed the opinion that chromium-molybdenum steel wire was more difficult to melt and work, but that no trouble should be experienced with it after the operator became accustomed to its use.

It was observed that when low carbon steel welding wire was used the melted metal ran through the junction of the two pieces welded and formed a uniform weld on the under side as well as on the upper side. With chromium-molybdenum steel welding wire this did not occur. The melted welding wire ran through the junction in places but did not form a weld of uniform thickness on the underside of the piece. This may be responsible, in part, at least, for some of the welded sheet breaking in the welds after heat treatment (Fig. 3).

Due to the thinness of section of the tubes and sheet the welding could be done very rapidly, consequently, the welded ends of the tubes and sheet became heated to bright redness only in the vicinity of the junction. One inch away from the junction the metal was at a black heat.

Physical Properties (Not Heat Treated)

The physical properties of the welded tubes and sheet are summarized in Tables IV, V, VI, and VII. Table IV gives the properties as welded (not heat treated) of the chromium-molybdenum steel tubes welded to chromium-molybdenum steel tube, using low carbon steel welding wire (Class 1A) and chromium-molybdenum steel wire (Class 1B). All of the fractures occurred about ½ inch from the weld. The location and appearance of the fractures are shown in Fig. 1.

Table V gives the properties as welded (not heat treated) of the chromium-molybdenum steel tubes welded to medium carbon steel (Classes 2A and 2B), and to low carbon steel tubes (Classes 3A , 3B), using low carbon steel and chromium-molybdenum steel welding wire. The properties of the chromium-vanadium steel sheet welded to chromium-vanadium steel sheet (Classes 4A and 4B), using both grades of welding wire, are also noted. The location and appearance of the f actures are shown in Fig. 1.

Table VI
Physical Properties of Chromium-Molybdenum Steel Tubes Welded to Chromium-Molybdenum Steel Tubes with Chromium-Molybdenum Welding Wire—Heat Treated

Class	11				12				13			
Heat Treatment	1625° F. Quenched in Water Tempered at 800° F.				1625° F. Quenched in Water Tempered at 1000° F.				1625° F. Quenched in Water Tempered at 1250° F.			
Specimen No. (Fig. 2)	A	B	C	D	A	B	C	D	A	B	C	D
Type of Specimen	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube
Diameter, original, in	0.998	1.000	0.997	0.999	0.999	0.998	0.999	1.00	0.995	0.997	0.999	0.998
Thickness of wall, in	0.033	0.035	0.034	0.035	0.035	0.033	0.033	0.034	0.035	0.033	0.035	0.032
Proportional limit, lbs. per sq. in.	.....	122,600	111,700	113,200	94,400	100,400	100,300	.....	66,380	64,900	66,200	.....
Ultimate Strength, lbs. per sq. in.	161,700	151,500	155,000	155,700	135,800	140,400	140,750	146,200	108,200	109,100	105,000	111,500
Elgonation in 2 in., per cent	4.0	1.0	3.0	3.5	10.0	7.5	11.0	8.0	17.5	17.0	17.5	14.0
Elongation in 8 in., per cent	2.75	0.62	1.37	2.0	5.12	3.12	5.37	5.0	7.75	8.5	7.88	7.75
Location of fracture	1 in. from weld	2½ in. from weld	At weld	At weld	1½ in. from weld	¾ in. from weld	⅜ in. from weld	2 in. from weld	1½ in. from weld	2 in. from weld	1½ in. from weld	3½ in. from weld
Character of fracture	Spiral	Spiral	Square	Square	Jagged	Spiral	Jagged	Spiral	Jagged	Jagged	Jagged	Jagged

Table VII
Physical Properties of Chromium-Vanadium Steel Sheet Welded to Chromium-Vanadium Steel Sheet with Chromium-Molybdenum Welding Wire—Heat Treated

Class	14						15							
Heat Treatment	1625° F. Quenched in Water. Tempered at 1000° F.						1625° F. Quenched in Water. Tempered at 1250° F.							
Specimen No. (Fig. 2)	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Type of Specimen	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet
Original width, in	0.505	0.506	0.501	0.510	0.512	0.506	0.504	0.504	0.501	0.500	0.499	0.502	0.503	0.502
Gage, in.	0.036	0.036	0.036	0.033	0.036	0.036	0.035	0.035	0.035	0.036	0.036	0.035	0.034	0.034
Yield point, lbs. per sq. in	89,800	93,300	66,600	77,270	81,460	67,000	81,670	73,720	77,000	72,370	72,400	72,870	68,700	72,620
Ultimate strength, lbs. per sq. in.	135,800	133,400	88,700	142,500	135,600	129,500	111,100	87,400	125,500	122,200	89,100	85,350	114,600	130,600
Elongation in 2 in., per cent	2.0	2.5	1.5	0.50	3.5	2.0	1.5	0.50	3.50	4.50	2.0	3.9	1.5	4.0
Elongation in 4 in., per cent	1.5	1.5	1.75	0.50	2.0	1.5	1.0	0.50	4.50	3.25	1.0	1.75	1.5	2.25
Location of fracture	2 in. from weld	⅛ in. from weld	At weld	2 in. from weld	⅛ in. from weld	Part in weld	At weld	At weld	1½ in. from weld	Next to weld	At weld	Next to weld	2 in. from weld	Next to weld
Character of fracture	Diag-onal	Diag-onal	Square	Diag-onal	Diag-onal	Irreg-ular	Square	Square	Diag-onal	Diag-onal	Square	Diag-onal	Diag-onal	Diag-onal

In Classes 2 and 3 fractures occurred in the carbon steel tube and at a considerable distance from the weld (Fig. 1). This was to be expected, as the carbon steel tubes had normally much less strength than the chromium-molybdenum steel tubes.

The welded chromium-vanadium steel sheet fractured close to the weld in about the same location as the welded chromium-molybdenum tubes, which lead to the supposition that in these two classes (Classes 1 and 4) a soft area existed ½ to 1 inch from the weld. In the case of the welded tubes, this was verified by Rockwell hardness tests.

The physical properties of all the specimens as welded (not heat treated) were fairly uniform; only in the case of the welded chromium-vanadium steel sheet (Class 4A) did any noticeable discrepancy appear. In every case the physical properties were satisfactory for the material tested. None of the specimens broke in the weld. This was to be expected, as there is considerably more metal at the weld. In order to get an accurate check on the strength of the weld, it would have been necessary to machine off the excess metal here before the specimens were tested. This was not done because welded tubes are placed in service as welded and it was desired to duplicate service conditions as closely as possible.

Physical Properties (Heat Treated)

The physical properties of the chromium-molybdenum steel tubes welded to chromium-molybdenum steel tubes after quenching and tempering are given in Table VI. In general, the physical properties are satisfactory, although lower in proportional limit, ultimate strength, and elongation than tubes of approximately the same composition not welded and

Table IV
Physical Properties of Welded Tubes—Not Heat Treated

Welding	Chromium-Molybdenum Tube to Chromium-Molybdenum Tube Low Carbon						Chromium-Molybdenum Tube to Chromium-Molybdenum Tube Chromium-Molybdenum					
Welding Wire												
Class (from Fig. 2)	1-A						1-B					
Specimen No.	1	2	3	4	5	6	1	2	3	4	5	6
Type of Specimen	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube
Diameter, original, in	1.001	1.000	1.000	1.000	0.998	0.999	1.000	1.000	1.001	1.002	0.997	0.999
Thickness of wall, in	0.033	0.034	0.032	0.033	0.034	0.033	0.033	0.034	0.033	0.033	0.033	0.032
Proportional Limit, lbs. per sq. in	52,400	52,320	51,520	.....	.....	.....	44,990	44,850	41,930	.....	.....	.....
Yield Point, lbs. per sq. in	.....	.....	.....	67,790	69,200	71,990	.....	.....	.....	73,990	75,890	70,900
Ultimate strength, lbs. per sq. in	101,400	102,000	103,050	98,990	99,900	100,100	100,100	100,050	100,100	101,000	102,500	103,200
Elongation in 2 in., per cent	4.5	4.5	4.5	2.5	3.0	4.0	3.5	5.0	4.0	4.0	3.0	4.0
Elongation in 8 in., per cent	1.12	1.12	1.25	0.62	0.87	1.12	1.00	1.37	1.12	1.12	0.87	1.12
Location of fracture						½ in. from weld						
Character of fracture						Square						

Table V
Physical Properties of Welded Tubes—Not Heat Treated

Welding	Chromium-Molybdenum Tube to Medium Carbon Steel Tube				Chromium-Molybdenum Tube Low Carbon Steel Tube				Chromium-Vanadium Steel Sheet to Chromium-Vanadium Steel Sheet			
Welding Wire	Low Carbon		Chrome-Mo		Low Carbon		Chrome-Mo		Low Carbon		Chrome-Mo	
Class Fig. 1	2-A		2-B		3-A		3-B		4-A		4-B	
Specimen No.	5	6	7	8	9	10	11	12	13	14	15	16
Type of Specimen	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Tube	Sheet	Sheet	Sheet	Sheet
Diameter, original, in	1.003	1.003	1.005	1.003	1.001	1.001	1.003	1.002	0.756	0.748	0.739	0.749[1]
Thickness of wall, in	.036	0.037	0.038	0.037	0.037	0.037	0.037	0.036	0.037	0.036	0.036	0.036[2]
Proportional limit, lbs. per sq. in.[3]	36,600	37,400	34,650	37,600	24,520	21,400	26,700	25,640	35,800	39,050	38,700	39,500[3]
Ultimate strength, lbs. per sq. in.	66,500	63,800	63,200	68,200	49,800	48,650	50,200	51,300	51,900	60,400	57,500	61,800
Elongation in 2 in., per cent	28.0	31.0	30.5	27.0	47.5	47.0	46.0	44.5	13.5	15.0	13.5	10.0
Elongation in 8 in., per cent	11.12	10.75	11.12	10.00	20.36	19.50	16.86	18.62	.....	.....	.....	.....
Location of fracture	3 in. from weld	2½ in. from weld	2½ in. from weld	2 in. from weld	3 in. from weld	3 in. from weld	3 in. from weld	2½ in. from weld	¾ in. from weld	1 in. from weld	¾ in. from weld	1½ in. from weld
Character of fracture	Square	Diag-onal	Diag-onal	Diag-onal	Jagged	Irreg-ular	Irreg-ular	Irreg-ular	Diag-onal	Diag-onal	Diag-onal	Diag-onal

[1]Width of sheet in inches.
[2]Thickness of sheet in inches.
[3]Proportional limit for tubes; Yield Point for sheet.

similarly heat treated (Table VIII). In only two instances (Classes 11C and 11D) did fracture occur directly in the weld and then with no sacrifice of strength or ductility. In contrast to the same tubes similarly welded but not heat treated, the fractures in the heat treated tubes (Fig. 2) were erratic in location. This led to the supposition, which was confirmed by the hardness tests, that the soft spot existing in the tubes as welded and causing fracture to occur at the same location each time (Class 1B, Fig. 1) had disappeared after heat treatment. The best combination of physical properties results from drawing temperatures between 1000 and 1250 degrees Fahr.

Chromium-molybdenum steel tubing welded to chromium-molybdenum steel tubing with chromium-molybdenum steel wire shows such a decided improvement when heat treated that members of this material should always be heat treated if possible. The only possible objection to heat treatment is warpage in quenching, which may become serious in tubes of such thin section.

Results of the physical tests on the heat treated chromium-vanadium steel sheet welded to chromium-vanadium steel sheet were erratic Table VII). In six out of fourteen tests the specimen fractured either wholly or partially in the weld (Fig. 3). When this occurred, the ultimate strength was approximately 70 per cent of the normal strength. The results given in Table VII indicate that chromium-vanadium steel sheet is not satisfactorily welded with chromium-molybdenum steel wire, although there is no doubt that the welded member is stronger than if welded with ordinary low carbon steel wire. A factor entering into the results shown in Table VII is the failure of the melted chromium-molybdenum steel welding wire to run through the junction uniformly and form a weld on both sides of the sheet.

The properties developed by the welded and heat treated specimens of sheet (Table VII) may be compared with physical properties of heat treated sheet of the same material and gage but not welded, shown in Table VIII. It will be noted that in those cases where the welded specimen developed its full strength, the ultimate strength was as high as for sheet not welded. The elongation is somewhat less and the proportional limit very much less in the case of the welded specimens.

In order to express a definite opinion regarding the welding properties of chromium-molybdenum steel wire for use with

Table VIII

Physical Properties of Chromium-Molybdenum Tubing and Chromium-Vanadium Sheet—Heat Treated

Tempering Temperature Deg. Fahr.	Proportional Limit, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.	Elongation in 2 in., per cent
Chromium-Molybdenum Tubing, A. S. Specification No. 10,231 C 0.34; Mn 0.52; Cr 0.94; Mo 0.31			
800	150,000	180,000	8
1000	125,000	145,000	12
1200	90,000	115,000	20
Chromium-Vanadium Sheet, A. S. Specification No. 10,206 Approximate Analysis—C 0.22; Mn 0.65; Cr 1.00; V 0.18			
800	105,000	145,000	3
1000	108,000	130,000	4
1200	95,000	115,000	5

chromium-vanadium steel sheet, the properties should be compared with those resulting from testing specimens welded with low carbon steel and chromium-vanadium steel welding wire.

Uniformity of Hardness Near the Weld

The Rockwell hardness results taken in the vicinity of the weld are given in Table IX for the untreated tubes and in Table X for the treated tubes. In the main, Tables IX and X are self-explanatory. In Table IX, the soft spot in the tubes is marked by an*. (See Table IX.) It will be noted that the soft spot occurs at a distance of ½ to ⅞ inch from the center of the weld. This was the location of the fracture in all of the specimens tested in Classes 1A and 1B. It is evident that heating for welding has had an annealing effect on the tube in this limited area. This annealing effect has been quite pronounced, as shown by the decided drop in hardness in this area.

The hardness of the heat treated tubes is fairly uniform, especially in the case of the specimen quenched but not drawn (Table X). In both specimens tested there was no soft area apparent; the hardness varied but little from end to end. The location of the fractures in Fig. 2 confirms the uniformity of hardness in that they were erratic in position, a decided contrast to the fractures of the untreated tubes, which all occurred in the soft area, as illustrated by the first two tubes in Fig. 1.

Metallography of Welded Tubes and Sheet (Not Heat Treated)

The structures of the chromium-molybdenum steel, medium

Table X

Rockwell Hardness of Welded Chromium-Molybdenum Steel Tubes—Heat Treated

Specimen	Regular Tubes 0.36 in. Wall			
Heat Treatment	1625° F. Quenched Water Not Tempered		1625° F. Quenched Water Tempered at 1000° F.	
Welding Wire	Chromium-Molybdenum		Chromium-Molybdenum	
Stations	Left	Right	Left	Right
Center of weld	46		18	
1 ..... ⅛ in.	46	44	25	25
2 ..... ¼ in.	48	45	27	25
3 ..... ⅜ in.	48	47	26	19
4 ..... ½ in.	48	46	26	20
5 ..... ⅝ in.	47	48	26	20
6 ..... ¾ in.	47	47	25	20
7 ..... ⅞ in.	46	48	26	20
8 ..... 1 in.	47	50	25	20
9 ..... 1⅛ in.	47	49	26	20
10 ..... 1¼ in.	47	47	26	19
11 ..... 1⅜ in.	47	47	26	19
12 ..... 1½ in.	49	....	25	18

Hardness tests made with diamond point and C scale.

Table IX

Rockwell Hardness of Welded Chrominum-Molybdenum Tubes—Not Heat Treated

Class		Regular Tube—0.036 inch				Heavy Walled Tube—0.125 inch—Used as check			
		1-A		1-B		1-A		1-B	
Welding Wire		Low Carbon		Chromium-molybdenum		Low Carbon		Chromium-molybdenum	
Stations		Left	Right	Left	Right	Left	Right	Left	Right
Center of Weld		66		106		No result		94	
1	⅛ in.	81	78	101	103	75	78	104	....
2	¼ "	102	102	101	101	90	85	85	75
3	⅜ "	102	102	101	102	93	94	96	102
4	½ "	96	100	96	93 x	92 x	86 x	96	103
5	⅝ "	90 x	93 x	86 x	88 x	80 x	90 x	87 x	96
6	¾ "	88 x	87 x	92 x	94 x	95	98	95	89 x
7	⅞ "	93 x	93 x	94	96	96	98	94	93 x
8	1 "	96	96	96	99	97	98	96	96
9	1⅛ "	95	97	97	100	97	98	98	96
10	1¼ "	95	97	96	99	97	102	100	100
11	1⅜ "	96	97	97	100	....	....	....	....

The "x" notes location of the soft area.
Hardness tests made with a ⅛ inch ball and B scale.

carbon steel, and low carbon steel tubes are shown in Figs. 4, 5, and 6, and of the sheet in Fig. 7. The structures shown are satisfactory and representative of the material before welding and heat treating. The grain size is small and uniform. No inclusions could be detected in the unetched specimen.

Figs. 8 and 9 show the structure at the junction of the chromium-molybdenum steel tube and the low carbon steel welding wire in the first case, and the chromium-molybdenum steel welding wire in the other case (Fig. 9). Both welds are very good; the one with the chromium-molybdenum steel wire (Fig. 9) has a finer structure than that of the carbon steel welding wire. The structure shown in Fig. 9 should have better physical properties than that shown in Fig. 8.

In Figs 10 and 11 are shown the structures at the junction between the medium carbon steel tube and low carbon steel welding wire (Fig. 10) and chromium-molybdenum steel welding wire. The grain size of the carbon steel tube shows the effects of heating for welding in the large pearlite grains surrounded by a ferrite network. The grain growth in the case of the medium carbon steel tube at the weld is much greater than with the chromium-molybdenum steel tube (compare Fig. 10 with Fig. 8 and Fig. 11 with Fig. 9). The structure of the low carbon steel welding wire (Fig. 10) is coarse, while that of the chromium-molybdenum steel welding wire is fine (Fig. 11). There is apparently some ferrite segregation shown in Fig. 11 at the junction of the tube and welding metal. In both welds (Figs. 10 and 11) the unions is perfect.

Figs. 12 and 13 show the weld between the low carbon steel tube and the low carbon steel welding wire (Fig. 12) and the low carbon steel tube and chromium-molybdenum steel wire (Fig. 13). In these, the weld with the low carbon steel welding wire (Fig. 12) is more homogeneous. A rather sharp dividing line is apparent between the low carbon steel tube and the chromium-molybdenum steel wire in Fig. 13. A peculiarity of the latter weld, shown in Fig. 13, is the fine grain structure of the low carbon steel tube, especially when contrasted with the structure of the low carbon steel weld with low carbon steel wire in Fig. 12.

In Fig. 13, the fine-grained structure of the chromium-molybdenum steel welding wire is noticeable. This fine grain was characteristic of all the welds made with this material and is a strong point in its favor. In general, a fine grain indicates better physical properties than a coarse grain.

Fig. 14 illustrates the weld between the chromium-vanadium steel sheet and low carbon steel welding wire ,and Fig. 15, the weld between the chromium-vanadium steel sheet and chromium-molybdenum steel welding wire. Again the structure of the chromium-molybdenum steel welding wire is very fine and the weld perfect. There is no doubt but that chromium-molybdenum steel wire produces a better weld than low carbon steel wire, from the standpoint of microscopic structure.

Comparing the general character of the various welds, as shown by the photomicrographs, it may be stated that chromium-molybdenum steel welding wire produces a weld having the most desirable structure, with chromium-molybdenum steel tube and chromium-vanadium steel sheet. With medium carbon steel tube both welding wires are about on a par and with low carbon steel tubes, the low carbon steel wire seems to produce the most uniform weld.

The chromium-molybdenum and chromium-vanadium steels

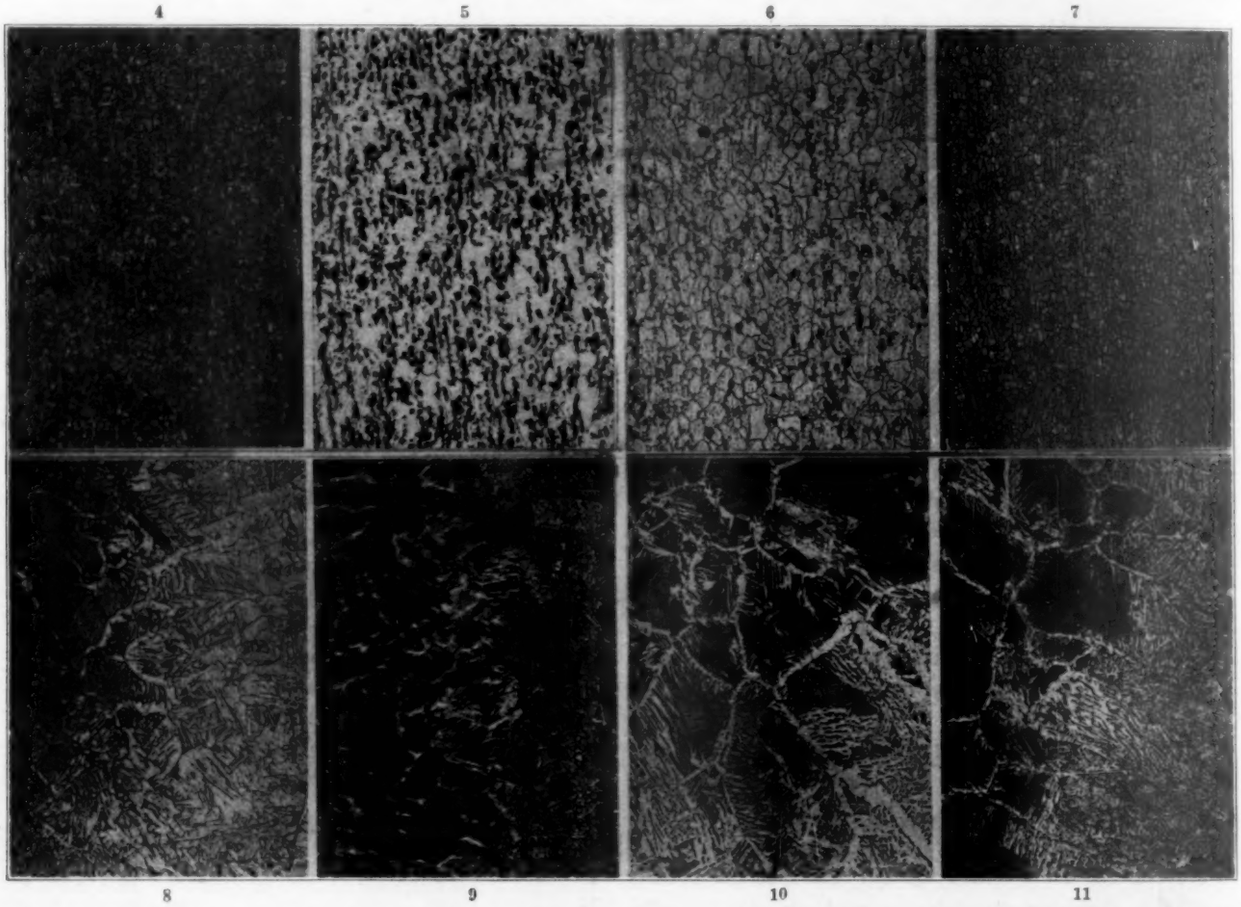


Fig 4—Photomicrograph of the Average Structure of Chromium-Molybdenum Sheet Tube Before Welding—Not Heat Treated. Fig. 5—Photomicrograph of the Average Structure of a Medium Carbon Steel Tube Before Welding—Not Heat Treated. Fig. 6—Photomicrograph of the Average Structure of Low Carbon Steel Tube Before Welding—Not Heat Treated. Fig. 7—Photomicrograph of the Average Structure of a Chromium-Vanadium Steel Sheet Before Welding—Not Heat Treated. All Magnifications 85 X.

Fig. 8—Photomicrographs of the Structure at the Weld of a Chromium-Molybdenum Steel Tube Welded with Low Carbon Steel Welding Wire—Not Heat Treated. Fig. 9—Photomicrograph of the Structure at the Weld of a Chromium-Molybdenum Steel Tube Welded with Chromium-Molybdenum Steel Welding Wire—Not Heat Treated. Fig. 10—Photomicrograph of the Structure of the Weld of a Medium Carbon Steel Tube Welded with a Low Carbon Steel Welding Wire—Not Heat Treated. Fig. 11—Photomicrograph of the Structure at the Weld of a Medium Carbon Steel Tube Welded with a Cromium-Molybdenum Steel Welding Wire—Not Heat Treated. All Magnifications 85 X.

used in the tubes and sheet are slightly air hardening, consequently, the structure of the tubes and sheet of these steels is mostly sorbitic at the welded end. The use of chromium-molybdenum steel welding wire produces a weld that is also sorbitic. It may be assumed that when both the material welded and the weld proper are fine-grained sorbite, the strength and ductility of the welded member will be greater than a weld between steel of sorbitic structure and a steel of almost pure ferrite. This holds only for strength and ductility, as there seems to be some doubt as to the ability of steel of sorbitic structure to resist fatigue. This will probably be made the subject of a future investigation.

Metallography of the Welded Tubes and Sheet (Heat Treated)

The structure of the weld between the chromium-molybdenum steel tube and chromium-molybdenum steel welding wire as quenched in water from 1625 degrees Fahr. is shown in Fig. 16, at 100 diameters, and, in Fig. 17, at 500 diameters. The junction between the tube and the weld has not been completely obliterated. The structure, however, is very fine-grained, more so than the same weld not heat treated (compare with Fig. 9). The difference in structure at the weld in Fig. 16 is probably due to the difference in composition between the tube which contained 0.23 per cent molybdenum and the welding wire which had 0.95 per cent molybdenum.

Figs. 18 and 20 (at 100 diameters) show the structure at the weld of the quenched tube after tempering at 800 and 1250 degrees Fahr., respectively. The structure shown in Fig. 20 is excellent as regards uniformity of structure and grain size. This structure indicates physical properties superior to the material as quenched or as quenched and tempered at 800 degrees Fahr. It will be seen from Table VI and from Fig. 2 that the strength, ductility, and character and location of the fracture are better, when considered together, when the quenched tube is tempered at temperatures exceeding 800 degrees Fahr. Figs. 19 and 21 are the same as Figs. 18 and 20, except that the magnification is 500 diameters.

Fig. 26, at 500 diameters, shows the structure of the chromium-molybdenum steel tube, quenched and tempered at 1000 degrees Fahr., taken 6 inches from the weld. The photomicrograph is introduced to show the average structure of the material not affected by heating for welding. The structure is fine and no grain boundaries are evident. It probably consists of sorbite, together with small amounts of the transition constituents always present when a hardened steel is reheated for tempering.

Figs. 22 and 24 (at 100 diameters) show the weld between the chromium-vanadium steel sheet and the chromium-molybdenum steel welding wire after quenching in water from 1625 degrees Fahr. and tempering at 1000 and 1250 degrees Fahr., respectively. In both specimens, the grain size is small and fairly uniform. In the case of the welded chromium-vanadium steel sheet the junction at the weld is more sharply defined than in the chromium-molybdenum steel tubes. This is especially noticeable when tempered at 1250 degrees Fahr. (Fig. 24). This sharper line of demarcation at the weld may be responsible, in part, at least, for the fact that so many of the heat treated specimens fractured in tension through or near the weld (Fig. 3). The structure of the welds for these two tempering temperatures is shown in

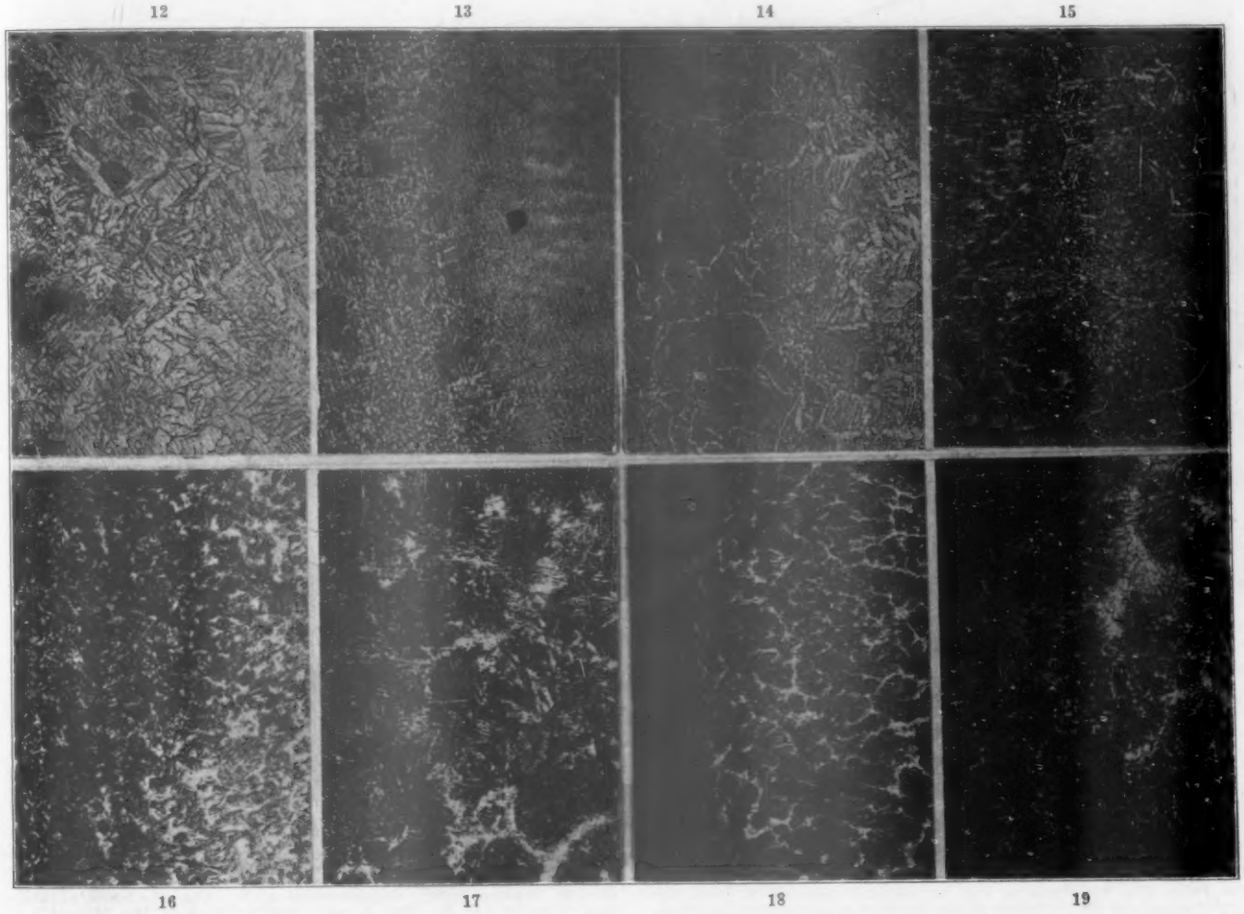


Fig. 12—Photomicrogrhp of the Structure at the Weld of a Low Carbon Steel Tube Welded with a Low Carbon Steel Welding Wire—Not Heat Treated. Fig. 13—Photomicrograph of the Structure at the Weld of a Low Carbon Steel Tube Welded with a Chromium-Molybdenum Steel Welding Wire—Not Heat Treated. Fig. 14—Photomicrograph of the Structure at the Weld of a Chromium-Vanadium Steel Sheet Welded with a Low Carbon Steel Welding Wire—Not Heat Treated. Fig. 15—Photomicrograph of the Structure at the Weld of a Chromium-Vanadium Steel Sheet Welded with a Chromium-Molybdenum Steel Welding Wire—Not Heat Treated. All Magnifications 85 X.

Fig 16—Photomicrograph of the Structure of the Weld of a Chromium-Molybdenum Steel Tube Welded with a Chromium-Molybdenum Steel Wire—Quenched in Water from 1625 Degrees Fahr.—Not Tempered. Magnification 85 X. Fig. 17—Same as Fig. 16. Magnification 425 X. Fig. 18—Photomicrograph of the Structure of the Weld of a Chromium-Molybdenum Steel Tube Welded with a Chromium-Molybdenum Steel Welding Wire—Quenched in Water from 1625 Degrees Fahr., Tempered at 800 Degrees Fahr. Fig. 19—Same as Fig. 18. Magnification 425 X.

Figs. 23 and 25 at a higher magnification.

It is evident that the heat treatment has not been of as much benefit in the case of the chromium-vanadium steel sheet as it has in the case of the chromium-molybdenum steel tubes. In fact, the structure of the welded and heat treated chromium-vanadium steel sheet is not as good as the structure of the weld, not heat treated (compare Figs. 22 and 24 with Fig. 15). Heat treatment, however, has undoubtedly had the effect of equalizing the grain structure in the vicinity of the weld and of eliminating any soft area that may be present due to localized annealing in welding.

Conclusions

In welding seamless steel tube and sheet with chromium-molybdenum steel welding wire, it was noticed that wire of chromium-molybdenum steel welding wire. Welding chromium-vanadium steel sheet with this wire also produced an excellent structure. In welding chromium-molybdenum steel tubing to medium carbon steel tubing, chromium-molybdenum steel wire apparently is but little better than low carbon steel wire, and in the case of a low carbon steel tube the structure of the weld with chromium-molybdenum steel wire is no better, and, perhaps, even inferior to the weld with low carbon steel wire.

Heat treatment of the welded chromium-molybdenum steel tubes and chromium-vanadium steel sheet has served to eliminate the soft area present near the weld in the untreated tubes and in general has served to equalize the structure at the weld and produce a fine grained uniform material. The

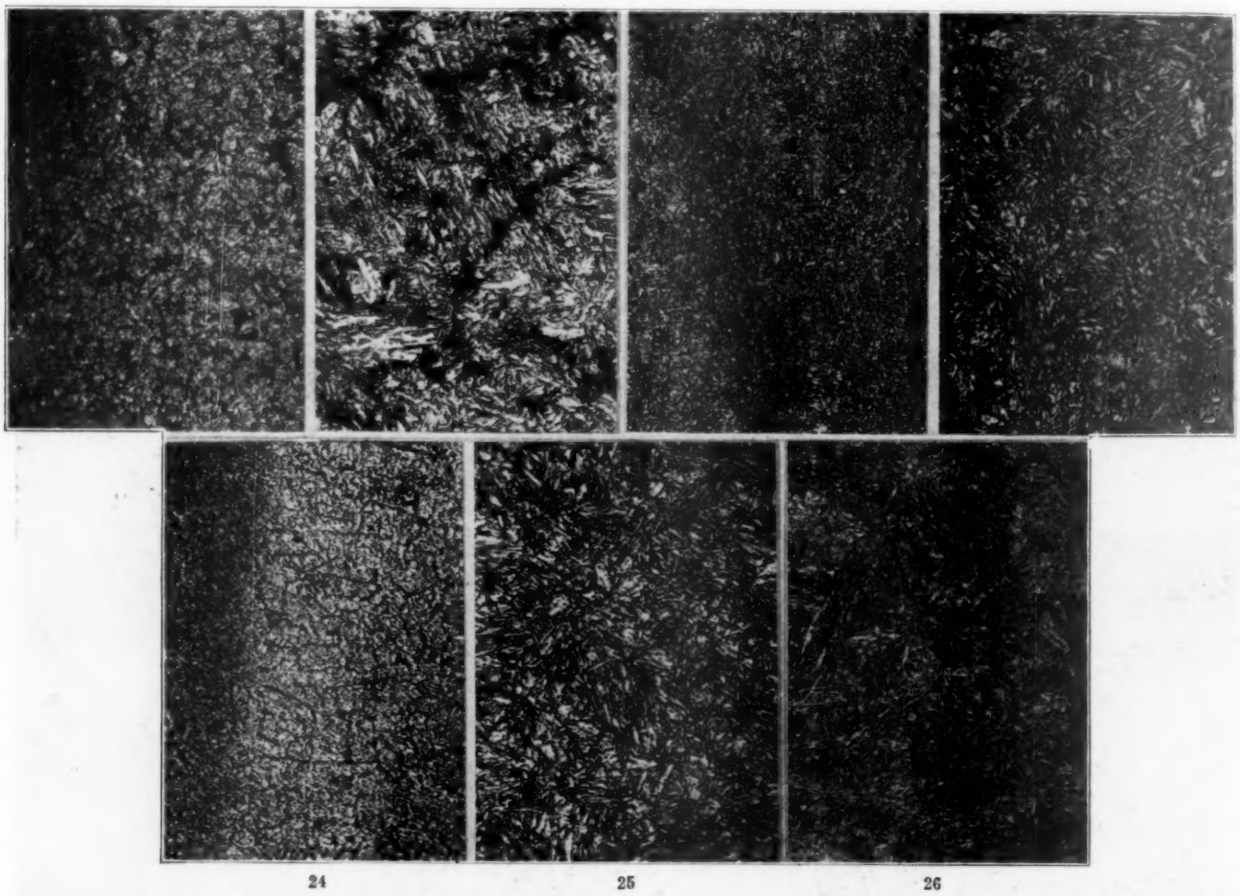


Fig. 20—Photomicrograph of the Structure of the Weld of a Chromium-Molybdenum Steel Tube Welded with a Chromium-Molybdenum Steel Welding Wire—Quenched in Water from 1625 Degrees Fahr., Tempered at 1250 Fahr. Fig. 21—Same as Fig. 20, Magnification 425 X. Fig. 22—Photomicrograph of the Structure of the Weld of a Chromium-Vanadium Steel Sheet Welded with a Chromium-Molybdenum Steel Welding Wire—Quenched in water from 1625 Degrees Fahr., Tempered at 1000 Degrees Fahr. Fig. 23—Same as Fig. 22, Magnification 425 X.

Fig. 24—Photomicrograph of the Structure of the Weld of a Chromium-Vanadium Steel Sheet Welded with a Chromium-Molybdenum Steel Welding Wire—Quenched in Water from 1625 Degrees Fahr., Tempered at 1250 Degrees Fahr. Magnification 85 X. Fig. 25—Same as Fig. 24. Magnification 485 X. Fig. 26—Photomicrograph of the Structure of a Chromium-Molybdenum Steel Tube Six Inches from the Weld—Quenched in Water frmo 1625 Degrees Fahr., Tempered at 1000 Degrees Fahr. Magnification 425 X.

this composition is more difficult to work than ordinary low carbon steel welding wire. It flows less easily and does not flow uniformly through the junction of the two pieces to be welded, and, consequently, does not form a uniform weld on the under side of the piece, as is characteristic of low carbon steel welding wire in the welding of thin sections. Welds made with chromium-molybdenum steel wire may be made as perfect, however, as welds with low carbon steel wire.

The physical properties of the various welded tubes and the sheet (not heat treated) are satisfactory, and, as a whole, uniform. Failure in tension always occurs at the weakest spot, which, in every case, was some distance from the weld. In the welded chromium-molybdenum tubing, a localized annealing took place about ¼ inch from the weld. With this material failure always occurred in this soft spot.

As regards the metallographic structure of the untreated welds, the most uniform and fine grained structure resulted from welding chromium-molybdenum steel tubing with best structure, and physical properties, as well, result from a tempering temperature of 1000 degrees Fahr. and above. Heat treatment, however, has not obliterated the junction of the tube or sheet and the welding metal. Probably a still better structure would result from normalizing, followed by quenching and tempering.

The effect of heat treatment is not so important in its improvement of physical properties as in the refinement and equalization of the structure at the weld, although quenching followed by a high tempering temperature improves the ultimate strength and elongation sufficiently to make it advisable to heat treat all welded chromium-molybdenum steel tubes and chromium-vanadium steel sheet, if possible.

An adverse factor entering into heat treatment of thin welded sections, such as tube and sheet, is the probability of the piece warping in quenching. For this reason, a simple normalizing treatment would probably be sufficient, except in the case of highly stressed members.

Arc Welded Post Caps

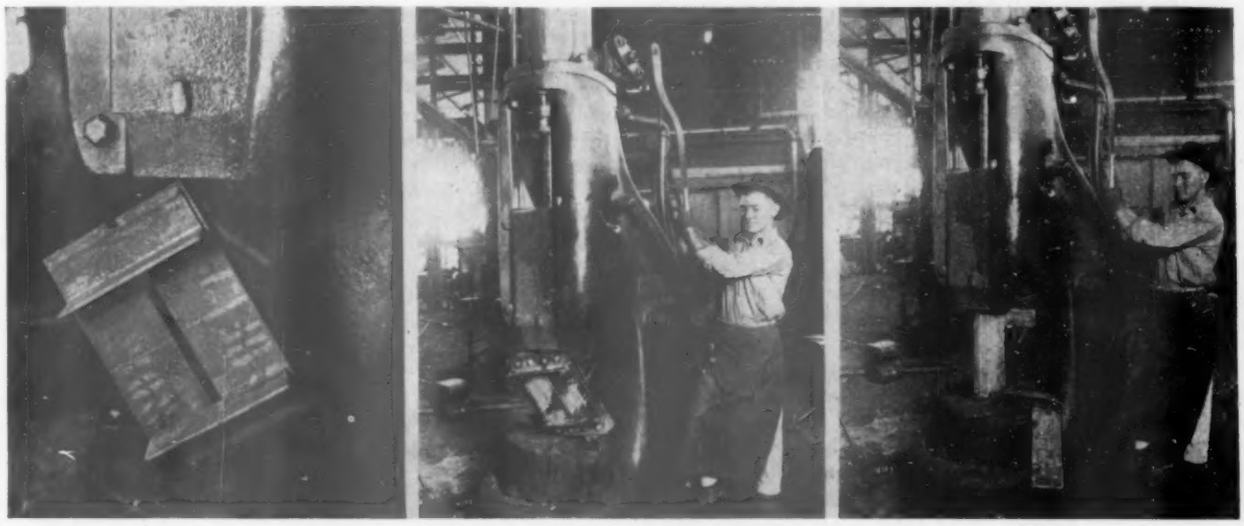
Manufacturer Finds That Welded Caps Promise Stronger Construction Than Riveting Will Give

A SAVING in labor costs of approximately fifty per cent has been effected by the use of welding instead of riveting in the fabrication of post caps by the Union Iron Works of Los Angeles. In addition to this substantial saving in labor, the new type of post caps are capable of withstanding approximately twenty-five per cent more strain than the old type of riveted caps, thus providing another strong testimonial of the worth and efficacy of welding in the steel fabrication industry, where rigidity and ability to withstand heavy strains are prime factors.

During the past several years, the Union Iron Works, one of the pioneer steel fabricating concerns in Los Angeles, has concentrated on a program of standardization and improvement of methods for the manufacture of various products from the standpoint of higher quality, greater production and lower manufacturing cost. Several months ago, the concern began a series of experiments with various methods of fabricating post caps so as to make them more rigid in construction without adding to their final cost.

Throughout the country, the riveting process has been used exclusively in the fabrication of post caps, which are used as a seat to connect wood beams with wood columns. Naturally, the Union Iron Works had been using the same process. The experiments commenced several months ago were directed along the line of making a better riveted post cap and, in this connection, various types of rivets and different methods of spacing were tried. The results obtained did not justify the further continuance of the experiments with riveting.

Then Robert P. Miller, vice-president and general manager of the concern, hit upon the idea of experimenting with welding to make the better post cap that was the ideal of the firm. The experiments entered upon to test out Mr. Miller's idea were made to determine the most suitable weld to be used between the angles in the post caps. Different lines of welding were tried in the experiments, with the result that it was decided that electric arc welding was the process best suited for this type of work.



Tests on Riveted and Welded Post Caps Show That Welded Caps Are Stronger

The post caps illustrated herewith are fabricated from four pieces of mild rolled steel, the edges being sheared off with an ordinary angle shears and not prepared in any way for the weld. The portion of the cap used as the seat for a wooden girder is 5 in. by 3 in. by $\frac{1}{16}$ in. and one foot 4 in. long. The other portion which fastens to a wooden column is 4 in. by 3 in. by $\frac{1}{16}$ in. and ten inches long. The welded seam is approximately ten inches long.

Using a reactance type electric arc welding machine and Weldite filling rods, operators have attained a speed of three inches a minute on the individual pieces of steel, which range in thickness according to the size of angles used, either $\frac{1}{4}$ in., $\frac{5}{16}$ in., $\frac{3}{8}$ in., $\frac{7}{16}$ in. or $\frac{1}{2}$ in. The welds do not have to stand any particular tension or compression, being simply to hold the pieces together rigidly, thus eliminating the use of rivets. No provision is made for contraction as the metal itself takes care of any such shrinkage. In welding the post caps, the two pieces of steel forming the seat and the other two pieces are clamped rigidly together.

Comparative strength tests were made by the Union

Iron Works between the old type of riveted post cap and the new welded cap. Both types of cap were held under and subjected to blows of a Bement-Miles steam hammer, each blow of which represented 3200 pounds. The riveted cap, with twice the usual number of rivets, began to fail at the fifth blow. The welded cap showed no signs of failing until after the sixth blow, but failed on the seventh. This showed conclusively that the welded cap stood more than one-fourth again as much strain as the specially-riveted cap. Estimating the difference in actual pounds, the welded cap withstood 6400 pounds more than the old type.

So the germ of Mr. Miller's idea became a successful reality and the welded post cap was adopted as standard by the Union Iron Works in place of the riveted post cap.

A. G. BISSELL MAKES ACQUAINTANCE OF CHICAGO SECTION

On Friday evening, November 6th, A. G. Bissell of the Westinghouse Electric & Mfg. Company, read a paper before the American Welding Society, Chicago Section, entitled "The Adaptability of Arc Welding to Structural Steel Fabrication." The subject of paramount interest in the paper was the strength of the arc welded joint in structural steel as shown by a series of tests made by Mr. Bissell in the Westinghouse laboratory. In the discussion which followed, the speaker won the friendship and respect of his audience by his prompt and frank replies to a number of questions which were raised by the audience.

The meetings of the Chicago Section are showing a progressively larger attendance, the November meeting being the best attended so far this year and it is expected that the speakers in future months will talk to a crowded assembly room. The next meeting which is scheduled for December 4th will be the first opportunity which the Chicago Section has had to discuss the subject of procedure control. The paper scheduled deals with the procedure control for welding cast iron heater sections and is to be presented by a member of the Linde Air Products Company Publicity Department. It has been suggested that all sections of the American Welding Society would do well to arrange for a definite program of work on procedure controls in order that the industry may have special information available covering the widest possible range of welding problems and welding operations.

NEW FACING MATERIAL—STOODITE

Stoodite is a very hard self hardening metal, recently put on the market by the Stoody Company, Whittier, California. It is composed chiefly of alloys and is a product of the electric furnace, and is specially adapted and recommended for facing the cutting edges of oil well tools, drawing and trimming dies, machine cutting tools, such as lathe tools, boring and planing tools, etc., and wherever a very hard cutting tool is required.

It is claimed that deposited metal when properly applied has all of the red hard qualities of the very best of high speed steel, and real economy is apparent in its use.

There is no special skill required in applying Stoodite, any good welder can attain excellent results. In applying to lathe tools or machine cutting tools it is necessary to keep each layer in a molten state a little longer than is usual with other rods, by allowing the torch to play upon it, this is very important where toughness is required, as the excessive alloys must be reduced. The welder need not be afraid of burning the metal, as refining is taking place at the time the metal is molten, it does not detract from the hardness but only adds to the toughness.

Stoodite is made in one size only, ¼ inch and 8 inches, packed in 5 lb., 10 lb., and 25 lb. bundles, paper wrapped and burlapped.

KERR'S WELDING COURSE APPEALS TO EXPERIENCED WELDERS

A letter received from Mr. R. R. Kerr, the author of Kerr's Training Course for Welders indicates that announcement of this correspondence course in oxy-acetylene welding has resulted in a much larger proportion of enrollment from experienced operators than from men who have not used the welding torch at all. A careful examination of the lesson sheets which have been prepared for this course suggests a very good reason for its popularity among men who have done considerable welding. It is evident, at a glance through the lesson sheets which cover a total of some ninety lessons, that great care has been taken to cover the fundamental principles of good welding in great detail. Hundreds of photographs have been taken especially for this work for the purpose of showing the results obtained both by correct methods and incorrect methods. A set of photographs like this is a fascinating subject for study by a man who is familiar with the principles involved and interested in finding out the cause of his occasional failures.

In the case of a welder who is desirous of improving his skill with the torch, it may be said that the illustrations used in the course are not only interesting but valuable in that they show him the reasons for past failures and through the text matter explain how these failures can be avoided in the future. This is undoubtedly the reason why the course has found favor with the men who have had some experience at gas welding. To the man who has never handled a torch or had the principles of gas welding explained to him, a great deal of the material contained in the course looks strange and formidable. The more experienced man, however, is more familiar with a lot of the terms used in the text and the illustrations are pictures of things to which he is accustomed to seeing in his daily work. He finds in the lessons a great deal of information which he has already absorbed but this serves to give him confidence in the ability of those who prepared the lessons so that the new points which are brought to his attention are applied by him with all seriousness and with full confidence they will help him get the better results for which he is studying.

Heretofore, the possibility of training welders by correspondence has not been favorably regarded in this industry and this is very likely due to the supposition that nobody would take the trouble to work out the training problem so carefully in detail as has been done in the case of the Kerr course. The author is certainly to be commended for his carefulness in presenting the principles of gas welding in a most painstaking manner and also for the excellent arrangement of material and the many little details of presentation which have been included to make the lesson sheets usable. There is no question but that the course will be well patronized as soon as it has been in operation long enough for the industry to become acquainted with the excellent possibilities contained in it.

CLEVELAND SECTION LEARNS ABOUT STRUCTURAL STEEL WORK.

On Tuesday evening, October 20th, the American Welding Society Cleveland Section held a meeting at the Hotel Winton, Cleveland, at which the principal speaker was Mr. R. A. Storm of the Morgan Engineering Company, Alliance, Ohio. This company has just completed a building in which all of the structural steel members were welded. The building in question is a two story building 100x150 feet.

Standard structural steel members were used on this building because the building was not originally designed for welding, but welding proved to be a cheaper operation than riveted construction would have been on the same work, and tests showed that the welded joints were stronger than riveted joints. The talk was illustrated by motion pictures.

Welded All Steel Auto Bodies*

Spot Welding Plays Important Part in the Body Construction—Pointers on Training of Spot Welder Operators

By Joseph W. Meadowcroft†
of the Edw. G. Budd Manufacturing Co., Philadelphia, Pa.

IF WE were to turn back a score of years we should find relatively few commodities produced from light gauge sheet metal and that the method of fabrication then in use was almost exclusively riveting. Riveting as a means of assembly caused much difficulty. Rivets were not driven tight. The rivet holes were over or under size; rivets were not driven in line with the axis of the center line of the rivet, and there were numerous other objections which we need not dwell upon here. It was due to the above conditions that so much stress was laid on the importance of finding a method of fabricating sheet metal products which would be useful in the construction of such commodities and which would yield more substantial and economical product.

Electric spot welding is the method which has replaced riveting, and this method of fabrication has been applied very successfully, because the welds are strong, the production is large, and all with lower cost and cleaner operation, and at the same time the capital investment in tools and the maintenance cost have undergone a notable reduction.

During the early days of electric spot welding sheet metal, much difficulty was encountered due to the failure of manufacturers of sheet metal to hold sheets to a uniform gauge. This gave the manufacturers of electric spot welding equipment the problem of building electric spot welding machines which would work by mechanical control in the switch, applying both power and pressure.

While this development work on welding machines was in progress, many steel mills were attempting to solve the problem of rolling sheets so that they could be held commercially uniform, which would then give us a material and a method of fabrication suitable for use in the construction of railroad coaches, aeroplanes, automobile bodies, etc.

Spot Welding Extensively Used in Body Building

We were the first to adopt this method for manufacturing all steel automobile bodies, and the first of these bodies were made in Philadelphia, June, 1912. This company is the first in the world to manufacture all steel automobile bodies and the success of producing these was due to the confidence the founders of our company had in this method of welding.

While many other manufacturers of sheet metal commodities were more or less dubious about electric spot welding, and were using other methods, such as soldering, riveting, etc., we were continually developing many new and special welding jigs and fixtures for welding the various parts of the product. Now we have become the largest users of welding equipment throughout the entire world.

In the design of an all steel body, much stress is laid on the design of the parts so as to secure the necessary rigidity into a minimum number of pieces so as to facilitate their ready assembly in the jigs and fixtures for welding. Welded joints and seams do not break open, nor do the metals wear upon each other, thus squeaks and noises are therefore eliminated. The assembled bodies are light in weight, durable, free from any defective joints and present an exterior surface smooth and free enough from imperfections to permit good finishing. Any surface irregularities, such as blow holes in seams or improperly closed joints, would act as a reservoir for the finishing material, and if enameled and brought up to 450° F., in a baking oven, would produce a blow or blister. The surface must be absolutely smooth, without depressions or cavities in which more than the standard thickness of enamel can flow, and so that the lacquers and color varnishes can be applied with the minimum amount of labor. A smooth, unbroken surface eliminated puttying or filling up of crevices.

When designing the various parts which are fastened together much stress is laid on the method of welding to be applied, and a strict standard is adhered to at all times. The size and construction of the various types of bodies produced for the many automobile companies play a very important part in the amount of welding used, but the average amount of welds on open type bodies is as follows:

1,000 to 1,100 electric spot welds
70 in. to 80 in. acetylene gas welding
10 in. to 12 in. metallic arc welding

On the full vision all steel sedan bodies, the average amount of welds is as follows:

1,600 to 1,700 electric spot welds
170 in. acetylene gas welding
11 in. to 12 in. metallic arc welding.

Developing of Special Devices Useful in Spot Welding

The various stampings are formed in dies and assembled in special electric welding machines of our own design, which have many special attachments, enabling us to weld all parts or units together and hold them uniformly. It is with the aid or assistance of these special fixtures that we are able to hold all parts which have contours in the proper position while welding them. It also insures safe and sound welds. This permits us to make sufficient allowance at all times in the special welding fixtures for expansion and contraction which so frequently is a source of trouble in welding large bodies of metals together.

Considerable time is saved in handling and welding the parts as they are so assembled that sufficient welds are placed in a short time, permitting us to produce large quantities of bodies on a small number of machines. Regardless of the method of welding used in connection with the assembly in the above machines, no time is lost in the manufacturing operations because each operator does his particular part, finishing with his helper or helpers within a specified time.

Another feature of economy in producing in these specially built welding machines is that the welding operators get the highest efficiency in the assembly and welding in the various parts of the body owing to the fact that the stampings or parts are interchangeable. Many operations are done on conveyors regardless of the method of welding used, this being done without any loss of time in the operation.

All of the various parts of the body are clamped together in such a manner that we are assured of good contacts in making spot welds. This is very essential in electric spot welding steel bodies, as it is necessary to spot weld the various sections of the body together so that the indentions in the metal are more or less eliminated. On some of the interior parts, which are not exposed, the indentions receive no consideration, as it is not necessary to do any finishing work, but in all cases where welding is used, whether it be interior or exterior, whether parts are perfectly flat or shaped, we make the proper allowance as mentioned above for contraction at the point of welding so that the bodies are held in their proper shape and to their proper dimensions. This makes it possible for fenders and other accessories which are made to a correct shape, to be interchangeable.

*Delivered before the Fall Meeting of the A. W. S., Cambridge, Mass., Oct. 23, 1925.

†Director American Welding Society, Past President Philadelphia Section, A. W. S.

Spot Welding Die Maintenance

In our daily production, 18,000,000 spot welds are made on standard and special electric spot welding machines, and the copper dies are designed under the supervision of the welding division, held to certain standards for shape, and size of material, and produced in quantities in the tool department. A stock of each copper die is kept in the tool booth in each assembly department, so that a quick exchange can be made at any time, but only a small supply of each die is kept in stock. This means we carry a small inventory of copper regardless of the vast amount of electric welding which is done.

Welding Personnel

Due to the tremendous amount of electric spot welding done in connection with producing steel automobile bodies, it is necessary to train a large number of men. In the training of men the qualifications of applicants for work as resistance welding operators which are of interest are as follows:

1. Age—18 to 25 years.
2. Height—Variable.
3. Weight—Variable.
4. Posture—Quick.
5. Hands, legs, and feet must be in good condition.
6. Eyesight—Must be in good condition.
7. Schooling—Grammar school at least.
8. Starting wage.
9. Length of training time.

The electric spot resistance welder welds on metal usually 1-16 in. in thickness. He must be able to adjust his machine in such a manner as to insure standard spot welds. The number of welds produced per machine per man when the machine is operated by hand or foot must average 10,000 to 25,000 spot welds daily, according to the size of the piece or pieces to be spot welded. Electric spot welding machines which are mechanically operated, produce 150 to 175 spots per minute. Men with mechanical experience or those who have worked around mechanical work are preferred. Electric resistance spot welding operators are more or less leaders in production, setting the pace for related operations, and it is essential that active, alert, and ambitious men be employed.

Instructions to Electric Spot Welding Operators

When electric spot welding apprentices receive their first instructions in the operation of electric spot welding machines, they are instructed very thoroughly as to the safety devices and tools required to be worn or used. A careful selection of clothing is made, for if an operator should wear an old torn shirt, coat, or any piece of clothing which is in any way ragged, it is apt to become ignited and cause a very bad burn. We strongly disapprove of the use of cotton garments, or those which contain a mixture of more cotton than wool, as the writer has seen a number of operators catch fire from sparks or flying molten metal, falling upon a fuzzy shirt or apron. The regular grade of blue woolen shirt commonly worn by workmen is about the safest garment that can be worn.

The operator wears an apron of leather which is of the proper size to protect him from a point high on the chest to the knees, and well around the waist towards the back. The operator is instructed to wear his apron at all times and not permit it to become oily or oil soaked without either having it washed or replaced with another apron.

Much stress is also placed on the selection of goggles. We have found that they should be so constructed that they are adjustable for the proper distance between the eyes, and it is also necessary for comfort that the temples or the part which is used behind the ear, should fit properly. The goggles should be well ventilated, but at the same time they should have the side shields and they must be so adjusted that there are no crevices around the outside edge for the sparks or molten metal to enter between the face and the goggle.

After the apprentice is equipped with goggles, apron, and the proper clothing, he is instructed as to the various parts of the electric spot welding machine and their use. He learns how to prepare a die or electrode, and to assemble them into water shank or die holder. After the dies or electrodes are assembled in the die holders, the apprentice is instructed how to adjust the electrode holder so that the upper and lower electrodes or dies are placed in alignment. He is also impressed at this time with the fact that he should never strike an electrode or die with any hard substance to place them in alignment, as the copper is soft and the threads are apt to become loose, resulting in a leak.

The apprentice then receives instructions on the following:

1. How to attach special accessories to electrodes, so that they can be used on two or three welding operations.

2. How to file electrodes or die points to the proper diameter to correspond with the gauge of metal to be welded.

3. What action to take when the electrodes become hot in operation.

4. The proper care of the locks on the water shank holders using the proper size wrench to lock water shanks or electrode holders in same. Under no consideration is the operator permitted to use a wrench on a lock nut which is not properly fitted for the part.

5. What action to take when threads on electrodes begin to wear.

6. Why he should never use dirty and blunt dies.

7. Why the regulator switch should never be changed while in the operation of welding.

8. Why no material of any kind should be placed on transformer in electric welding machine.

9. Why water tubes should always be placed ¼ in. from the end of electrodes.

10. Why no attempt should be made to weld rusty or scaly material.

11. Why it is necessary to have the water shank holders held firmly in water shanks.

12. Why he must watch connecting wires on switch.

13. How to assemble contact plugs.

The six basic causes which make repairs to electric spot welding machines necessary—

a. Insufficient or improper lubrication.
b. Presence of dirt on bearing surface.
c. Misuse of machine.
d. Imperfect adjustments.
e. Vibration.
f. Unavoidable wear.

He is instructed in the proper supervision of machines as to the systematic inspection which takes care of the first four causes—lubrication, dirt, misuse, and adjustments. As each man finishes his training, he is placed in one of the assembly departments under the supervision of one of the welding foremen, who is responsible for the quality and quantity of the work turned out by the apprentice. The apprentices are advanced from time to time in accordance with their ability to do higher class work, and as all operators are paid in accordance with the class of work they are doing, there is always a goal to work for, which obtains the best results for both parties.

The time study of welding operations is done by men who are thoroughly familiar with welding operations. They see that the operations are so separated that they can be performed in a highly efficient manner. Each and every operation is inspected, which means that the accuracy of the previous operation is assured. The inspectors are also men who have had more or less training in the art of welding, and at various time periods they make inspections of welds while they are being made, instead of after the welds are finished. By handling the inspection of welds in this manner, the inspector not only holds the quality of the welds to a high standard, but assists the welding, operator regardless of the operation, to become more efficient in obtaining a production output satisfactory in both quantity and quality.

General Observations on Spot Welding Practice

When two metal sheets are spot welded together in accordance with the customary practice, the fusing of the metal and the pressure applied results in the formation of a low spot weld. The thickness of metal at the weld is slightly less than the combined thickness of the two overlapped sheets in an unwelded portion. This difference in thickness is not very great, but where a finish is to be applied to the surface of one of the sheets, it is objectionable, since these low spots give an undesirable appearance to the finished surface. To overcome this difficulty it has been the practice to eliminate these low spots by grinding off the surface so as to bring it down to the same level as the weld. This practice is slow and costly, but heretofore it has been necessary in order to produce a satisfactory surface. This condition of low spots in sheet metal is a very serious item, and much depends upon the method of handling the process while welding as to whether or not you can produce the so-called low spots in such a manner as to have only a minimum amount of finishing.

In some cases, where spot welds are made on radii, it is possible to spot weld metal sheets together in such a manner as to cause part of the metal at the weld to project or protrude above the surface of the surrounding metal by forming a small projection at the weld. The weld is so made that this projection protrudes from the surface to be finished—that is, the surface in which any low spots would be objectionable as stated heretofore. After the metal sheets have been joined together by a series of welds made in this manner the small teats or projections are removed in any suitable manner—as, for instance, by grinding them down to the level of the surrounding surfaces. This new surface then has on low spots, and its appearance, when finished, will be very desirable.

The lower electrode is of the form commonly used on all makes of electric welding machines and the upper electrodes are of the usual form except that they have a small conical recess arranged centrally in the lower end of electrode. The metal sheets are inserted between the electrode having the recess. The electrodes are caused to approach each other and engage and clamp between the overlapped metal sheets, the electrical circuit being so closed that the current flows from one electrode to the other through the metal sheets. The heat generated by the passage of the electric current through the metal sheets, at the point where they are engaged by the electrodes, causes the metal to fuse and, since the electrodes apply considerable pressure at this point, the fused metal is also forced into the recess of the electrode forming the small projection at the weld which protrudes from the surface to be finished. A "low" spot will also be formed at the weld in the exposed surface of the sheet, but this is not objectionable, since this surface is not to be finished. When the sheets are connected by the usual spot welding operation, such low spots are formed in both of the exposed surfaces and it is to be noted that with this process of spot welding, these low spots are eliminated.

The second step in this process consists in the removal of these weld projections. This is done very satisfactorily by grinding or filing them down to the level of the surrounding surface. The result is that the exposed surface of the metal sheet is uniform and without any objectionable depressions. In using this method in actual practice, the metal sheets which are joined together have been of steel and the electrodes which are used have been of copper.

It is to be noted that, by the use of this process in cases where one of the surfaces of these welded members is to be finished, the work can be accomplished at a lower cost than heretofore. The welding operation is no more costly and no slower than heretofore and the amount of grinding necessary is much less than has been required, previously. It is a much simpler and cheaper operation to grind the weld projections down to the level of the surrounding surfaces, than to grind the surface down to the level of the "low" spots, at the welds.

Strength of Spot Welds

The question is frequently asked, how do spot welds and riveted joints compare in strength. It is not my intention to go fully into this question here, but I may say briefly that there is no substantial difference in our use of them. If two thin pieces of metal and two thick pieces of metal be riveted with rivets of the same size there is a certain thickness of metal below which all failures will arise through the tearing of the sheet and above which failures will be due to the shearing of the rivet. The same is true of spot welds if the area of the spot weld be held constant. The table below gives test results on spot welds applied to sheets of different thickness, but the area of the weld itself is nearly constant. In the examples given when the thickness of the metal is above .062 inch, the weld itself undergoes shear. Had the area of the weld been greater, the weld would have failed in shear only with a greater thickness of metal. Exactly the same thing happens with rivets. When the section of the rivet is small and that of the sheet large, it is always the rivet which fails.

Tensile Tests of Spot Welds in Sheet Metal

Metal Thickness, Steel	Area of Weld	Load, Lbs.	Shear Stress on Weld per Sq. In.
.031	.048 sq. in.	800	16,700—Sheet broke around weld
.043	.055 sq. in.	1,470	26,800—Sheet broke around weld
.050	.051 sq. in.	1,230	24,300—Sheet broke around weld
.062	.054 sq. in.	2,140	39,600—Sheet broke around weld
.078	.049 sq. in.	2,210	45,000—Broke through weld
.088	.0594 sq. in.	2,820	47,400—Broke through weld

Tensile Tests of Rivets in Sheet Metal

Single Rivets—These rivets were headed by machines as used in the shop. The bucking up tool was a diamond knurled flat surface. Force was applied to the head of the rivet by an air hammer fitted with a die made to suit mushroom head of rivet. The diameter of the rivets was .257.

Metal Thickness	Load, Lbs.	Shear Stress on Rivet —lb. per sq. in.
Steel..... .025	840	17,100—Rivet pulled out of strip
Steel..... .039	945	19,300—Rivet pulled out of strip
Steel..... .048	1,500	30,600—Rivet pulled out of strip
Steel..... .059	1,395	28,400—Rivet pulled out of strip
Steel..... .070	2,010	41,000—Rivet pulled out of strip
Steel..... .088	2,175	44,300—Rivet sheared off

Two Rivets:

Metal Thickness	Load, Lbs.	Shear Stress on Rivet —lb. per sq. in.
Steel..... .039	1,355	13,800—Metal strip broke
Steel..... .057	2,460	25,300—Metal strip broke
Steel..... .088	4,265	47,400—Metal strip broke

Single Rivets—Rivets used were $\frac{1}{4}$ in diameter and were mushroom headed both sides. Riveting done with air hammer.

Metal Thickness	Load, Lbs.	Shear Stress on Rivet —lb. per sq. in.
Steel..... .031	705	25,300—Rivet pulled out of strip
Steel..... .043	945	34,400—Rivet pulled out of strip
Steel..... .050	1,110	40,200—Rivet pulled out of strip
Steel..... .062	1,490	53,900—Rivet sheared off
Steel..... .078	1,610	58,200—Rivet sheared off
Steel..... .088	1,325	47,800—Rivet sheared off

Two Rivets—Same diameter rivets used—same type head.

Metal Thickness	Load, Lbs.	Shear Stress on Rivet —lb. per sq. in.
Steel..... .062	1,770	12,850—Metal torn and rivets pulled out at side of holes
Steel..... .088	2,945	21,300—Metal torn and rivets pulled out at side of holes

Safety—first—last—

These vent holes are required by the Underwriter laboratories in all regulators. But even these vent holes are not sufficient to prevent the rupture of the bonnett should the diaphragm burst under sudden pressure.

This is how RegO Regulators are protected from excessive pressure. The knife edge is set at a fixed distance from the diaphragm. Any excessive pressure of gas is released slowly because of the manner in which the knife edge penetrates the diaphragm—thus sudden bursting is absolutely impossible!

The Bastian - Ble
246 E. Ontario Stree

t—and all the time!

RECENTLY a laboratory of national standing made a severe test on twelve Rego regulators picked at random from the stock room of the Rego factory. These regulators were subjected to tests far more severe than could possibly occur under normal conditions.

Not one Rego regulator could be made to burst.

The Rego shearing device prevents bursting of body.

This shearing device has keen knife edges that are set at a fixed distance from the diaphragm. Should gas pressure increase suddenly through accident to the seat, the diaphragm will be bent outwards and before it reaches its breaking point, the knife edges of the shearing device penetrate the diaphragm and slowly release the pressure. Should there be no shearing device, the diaphragm will burst--and the sudden bursting followed by a rush of the expanding gas, has been known to blow the spring housing off a regulator, even though properly vented.

The Rego shearing device is patented by the manufacturers of Rego equipment. No regulator that is not made in the Rego factory can contain this particular safety feature. If you want to be really sure that you have a safe and efficient regulator, buy Rego.

REGO SALES REPRESENTATIVES

Syracuse, N. Y.	National Welding Equipment Co.	517 E. Water St.
Louisville, Ky.	Kentucky Oxygen-Hydrogen Company	Logan St. and Gross Ave.
New York, N. Y.	Weldox Equipment Co.	359 W. 52nd St.
Dallas, Texas	Southwest Welding Supply Co.	209 S. Pearl St.
Kansas City, Mo.	Western Welding Equipment Company	308 E. 17th St.
St. Paul, Minn.	St. Paul Welding & Manufacturing Co.	174 W. Third St.
Portland, Ore.	Welder's Equipment & Supply Co.	91 North Second St.
Los Angeles, Calif.	A. W. Courtney	441 Douglas Bldg.
San Francisco, Calif.	Stuart Oxygen Company	215 Bay St.
Seattle, Wash.	A. C. Eck Company	914 First Ave. S.
Butte, Montana	Mountaineers Welders Supply Co.	
Seattle, Wash.	Ferrofix Brazing Co.	816 First Ave. S.
Toronto, Canada	Carter Welding Co. of Toronto, Ltd.	165 Adelaide St. W.

lessing Company

reet Chicago, Ill.

A. W. S. Boston Convention

Fall Meeting Features Several Papers Which Furnish New Information on Important Welding Operations

By R. K. Randall

THE Fall meeting of the American Welding Society opened up at the Massachusetts Institute of Technology, October 21, 1925. Mr. T. A. Wry, the genial chairman of the Boston section was on hand for the registration and he and his co-workers made all feel a real Boston welcome. Each guest was given a badge with the emblem of the city seal, state seal, and old Fanuiel Hall on it, a really beautiful memento of the meeting.

Banquet Which Completed Fall Meeting of American Welding Society at Boston

The spacious halls of the school were filled with every kind of welding and welding accessory exhibits. There were automatic cutting and acetylene welding devices, Electric arc welding equipment, both of the automatic and hand operated type. Actual demonstrations of thermit welding was also given. Practically every type of apparatus, both electric and acetylene, was represented and shown in actual operation. *The Welding Engineer* had a booth near the main entrance and the display of its different publications indicated how much work is being done by this organization to promote the use of welding processes.

The demonstrations were continued until 9 P. M. and from morning till night a highly interested crowd surged through the building and showed unusual interest in each feature.

At 6 P. M. a fine buffet lunch was served in the Walker Memorial building.

The technical sessions were largely attended—300 being present both morning and afternoons. The following is a brief summary of the papers given at Monday's meeting. The meeting was presided over by Mr. A. G. Oehler, President of the American Welding Society.

Mr. R. L. Browne said that his concern had successfully overcome the presence of blow holes in thermit welds by using a shop silica sand and a plastic clay. He stressed the point that all foundry sand was not suitable for thermit molds. With the old style dense molds all of the gas in the weld was forced to make its escape through the molten metal and some of this gas was of course entrapped in the weld as it solidified. With the use of the new molding material which absorbs or lets gases out through the mold, the problem of blow holes has been removed from thermit welding. Another step forward has been to cut down the amount of Thermit used on a given job and use smaller gates and risers and the saving in this manner has decreased the cost of the operation due to the saving of material in many cases as much as 50%. A discussion followed and several railroad men explained a few problems on thermit welding locomotive frames.

The afternoon technical session was opened by Mayor Quinn of Cambridge who cordially welcomed the society to his city, and told some interesting facts about Cambridge, Massachusetts, and the position the city held in the country's educational field. Following the Mayor's address Mr. S. W. Moulder, Chief Engineer for the Grinnel Co., presented a most interesting paper on "Gas Welding of Power Plant Piping." Mr. Moulder started by stressing the point about the "Human Element." The human element is a factor that cannot be measured. Quality workmanship is most necessary and there is no substitute for integrity. The plain butt weld has been proven to be superior to any other elaborate designs that have been tried. Among the advantages to be gained through welded pipes comes the fact of lower cost. In one case a header for a battery of several boilers with outlets and connections was constructed by welding at a cost of $332.00. The old method of cast flanges and steel fittings would have cost $1,034.00.

The second feature mentioned was the saving of weight. In the foregoing case the weight saved was 2980 lbs. The space saved by eliminating flanges is in many cases an item. Conduction of heat through heavy steel or cast iron flanges was another point Mr. Moulder mentioned.

The possibility of a "code" was talked on and Mr. Moulder suggested a committee should be appointed to work with the A. S. M. E. committee and formulate a code that would be proper.

Thursday afternoon's meeting was presided over by E. H. Ewertz. H. M. Hobart and W. Spraragen presented a paper on the subject of "Arc Welding as a Manufacturing Process." Many applications of arc welding have been brought about through economic reasons. Increased production, lower costs, improvement of quality were some of the reasons cited.

The importance of design for welding was brought out and through proper design greater efficiency of the weld is procured, and a great saving is effected in material and weight. An electric weld is a section of steel casting. The weld will not

stand bending stresses to the same extent as a steel forging. The arc weld stands tension stresses best. The selection of material is of great importance and the paper brought out the fact that in steel over 0.20 carbon there is apt to be a hard brittle zone. Low carbon steels between 0.10 and 0.20 offer the best material for arc welding. A simple torch test for welding wires was mentioned namely that of melting the surface of the wire with a soft acetylene flame. If the wire contains elements detrimental to welding these impurities will rise to the top. Chemical composition, however, is not a complete criterion as wide variations of deposit are obtained when welding wire of identically the same composition is used. The physical structure and gas content may have influence on the deposited metal. The phenomena are still far from being understood. It was brought out that a welder's complaint should never be ignored as he is in a position to observe unusual conditions in the arc caused by inferior electrodes.

The tendency seems to be for the use of larger electrodes in order to increase deposit and higher current values to increase speed.

The paper ended with the mention of many ways in which arc welding could successfully be used and from the number of applications mentioned it would seem that any concern whose product is made from steel, the arc can help them increase the production and strength of their products.

Mr. Morris Holland presented the opening paper at the research committee meeting. Mr. Holland pointed out the value of research work. England, he said, spent $5,000,000 a year in research work. The value of research work, he pointed out, lays in the fact that it speeds up the growth of any industry. He pointed out that the great concerns such as the telephone and the motor industry owe much to research work for their rapid growth. Research, he said is a gear to speed up industry. U. S. is spending $100,000,000 a year for research work. The U. S. Government is contributing one-third of this and individual corporations are furnishing the other two-thirds. Colleges are also contributing with their facilities to help this great work. Professor Adams of the Harvard Engineering School pointed out that the lack of fundamental knowledge was due to the fact that the rule of thumb was too frequently applied. The American Bureau of Welding has many contracts which makes it possible to do much research work at practically no cost. He pointed out that the early injection of research work will speed up the welding industry tremendously.

The solving of a problem justifies an expenditure of huge sums because the economic saving is many times more than the amount spent.

Professor Kinsey reported at this meeting that the boiler code committee of the A. S. M. E. were considering the readjustment of their figures of allowances and both forge and fusion welding. The entire industry should contribute freely to the research funds as all benefit directly through it. Little is actually known about a weld as the industry is governed largely by tradition, rather than deep thinking.

The future activities were outlined by Mr. Sprargen and include a new investigation into the matter of un-fired pressure vessels and investigation into the structural steel field for which $150,000 is needed. It was brought to the attention of this meeting that the A. S. M. E. would not modify their rules until the actual facts on weld metal fatigue and the effect of heat on weld metal has been really determined. Research work alone can supply these facts.

The report of the Rail Welding Committee makes it appear that at a date not far distant we may expect more welding of rails into long lengths as the expansion and contraction problems are probably over-exaggerated. Many miles are welded now and apparently cause no trouble if every third or fourth joint is left open for expansion.

The banquet and theater party Thursday evening was a most enjoyable time. Mayor Curley of Boston extended a most cordial welcome to this city and reviewed briefly the part that Boston played in the making of the country. The program was broadcast by station WNAC and as far as can be ascertained it is the first time that welding has ever received publicity through the medium of the new marvel, radio. After the banquet taxicabs were furnished and the members and guests were taken to see "The Student Prince," sections having been reserved for them. Friday morning's meeting on "Wire To Use" developed much of interest as to the relative merits of bared and covered electrodes. One point that had great stress laid on it was that all experimental work should be conducted with an automatic machine, as this would eliminate the human element with its varying factors as much as possible. It was also pointed out that as much attention should be given to the metal to be welded as there is given to the welding wire used, as good welding wire can produce unsatisfactory results on certain grades of steel.

The closing meeting Friday afternoon was largely attended and the paper given by Mr. J. W. Meadowcroft together with the moving pictures with the manufacturing of "All-Steel Automobile Bodies" was a fitting end to a series of most interesting meetings. Much clever repartee took place at this meeting when the body of a well-known automobile was shown in the process of making. The paper presented some interesting figures such as the average number of welds on an open body. These figures showed 1000-1100 spot welds. 70-80 inches of gas welding. 10-12 inches of Electric Welding.

On the average sedan body the figures are:

1600-1700 Electric Spot Welds.

170 inches of Gas Welds.

11 inches of Electric Arc Welding.

18,000,000 spot welds are made in daily production. A single operator has made 25,000 spot welds in one day. Jigs and special devices for holding work are of great importance in this field. The strength of a spot weld properly made is very high and tests show that the sheet itself will tear before the spot weld will let go.

At the close of the convention it was estimated that fully 25,000 people passed through the halls and saw the exhibits. The students attending the M. I. T. were interested in all they say and the effect on the welding industry when these future architects and engineers start to practice their profession will undoubtedly be felt.

Professor Stratton whose generosity permitted the holding of the convention in his school is entitled to a vote of thanks from all.

A CLEARING HOUSE FOR USED ELECTRIC EQUIPMENT

The Goodman Electric Machinery Company of Newark, N. J., occupies a unique position in the electric welding field. This company buys used electric welding equipment and resells them under a guarantee after they have been thoroughly overhauled and rebuilt. Since they act as a sort of clearing house for equipment of this sort they can be looked upon as either possible purchasers of machines which are no longer wanted or a source of supply for those who are in the market for used equipment. It is also possible to rent machines from them for temporary jobs.

LOS ANGELES SECTION ORGANIZED

With the election of permanent officers and an executive committee and the adoption of by-laws, final organization of the new Los Angeles chapter of the American Welding Society was completed at the September 24th meeting of the group.

L. G. Hicks was elected chairman; F. S. Hatfield was chosen vice-chairman, and L. R. Ardouin, of the United States Steel Products Company, was made secretary and treasurer. The executive committee, consisting of the three officers and Barton Brown, of the Barton Brown Engineering Company; Oscar Lund and A. Max Lee, was also selected at the meeting.

Regular meetings of the Los Angeles chapter will be held on the last Thursday of every month and will be the occasion for the exchange of ideas and the description of practices of the welding fraternity in the immediate vicinity of Los Angeles. It is expected that a great many new practices and methods in connection with the use of welding in the oil and mining industries will be brought forth in the near future through these meetings.

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Reg. U. S. Pat. Office.

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,

608 S. Dearborn St., Chicago, Ill.

Telephones Wabash 7134 and 7140

G. H. Mackenzie.....President and Treasurer
M. J. Hungerford.....Vice-President
H. S. Card.....Secretary

H. S. Card.....Managing Editor
W. W. Brothers.....Editor

Eastern Office—222 American Circle Bldg., New York
T. E. DePew, Eastern Manager
Telephone, Columbus 6941

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries.....$4 a year
Single copy, domestic.....25 cents
Single copy, foreign.....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

The Welding Engineer in Great Britain

Capt. D. Richardson, Northampton Polytechnic Institute, Clerkewell, London, E. C. 1, England, is our accredited representative in Great Britain for obtaining new subscriptions to The Welding Engineer and The Welding Encyclopedia.

The Welding Engineer in Australia and New Zealand.

Mr. R. Hill, Matlock House, Devonport, Auckland, New Zealand, is our accredited representative in Australia and New Zealand for obtaining new subscriptions.

VOLUME 10 NOVEMBER, 1925 NUMBER 11

CONTENTS

Cutting Cast Iron on State Street.....15
Chromium Molybdenum Welding Wire.....17
Arc Welded Post Caps.....25
Welded All Steel Auto Bodies.....27
A. W. S. Boston Convention.....32
Editorials.....34
Welding Solves Boiler Problem.....38
Welded Power Plant.....40
News of the Welding Trade.....46
Current Welding Literature.....47

A Control for the Human Element

CONTRADICTORY opinions regarding the importance of the human element have prevailed in the welding industry for a number of years. In the same organization it has been common to find those who believe that the great problem is to get good welders and those who believe just as strongly that getting good welders is no problem at all. Of course they are both right. It is easy to get good welders if you know how to train them, but it is hard to get superintendents to adopt a rational plan of training. It is so much easier to hire a man who claims to have been trained, and fire him when he turns out to be another bluffer. So attention has gradually centered upon the matter of supervision. It has been often charged against welding that you cannot judge the value of a welded joint without destroying it, but any good welding supervisor will challenge the statement. One skilled in gas welding can tell by the movement of the rod in the puddle, by the appearance of the flame, by the appearance of the puddle, and dozens of other signs, whether the operator is getting the right kind of fusion, an arc welder also recognizes the signs of good and poor workmanship, and it is no trick at all to pick out a poorly working piece of resistance welding machinery. And when the work is done its appearance tells a definite story to the experienced supervisor. So the sentiment is swinging away from asking the welder to take all of the responsibility, with all due respect to the necessity for having conscientious welders, and place it on a supervisor who knows enough about the process to exercise really intelligent supervision.

About the Eye Hazard

MANY men who have carelessly exposed their eyes to the electric arc, and there by contracted a mild case of conjunctivitis, harbor the opinion that they have narrowly escaped blindness. Their stories become more thrilling with each telling and they look upon the welder as a brave (or foolhardy) man who risks his precious sense of sight to follow his calling. Protective devices have, as a matter of fact, removed all the hazard from the operation. There are no bad effects from welding which are either unavoidable or permanent. We have yet to see a welder so noticeably impaired in vision as some of the old time boiler makers are hard of hearing, if he has taken ordinary precautions. It is a lack of understanding which has created a wrong impression. Practically every industry has its individual hazards, and safety campaigns have found and perfected safeguards for all of them.

Idle Torches Pay No Dividends

SCATTERED over the country are hundreds of small shops which are equipped with everything necessary for welding except two tanks of gas and the ambition to make the torch pay a profit. A failure or two have been closely followed by complete discouragement, and a tool which might easily be made a source of good revenue is thrown into a corner and forgotten. It can save from the scrap pile many pieces of metal which cost more than it did. The forgotten torch ought to be put back in service.

Buy Christmas Seals

TUBERCULOSIS Christmas seals are again for sale on the candy counters, cigar stands and hotel desks of the country. Millions of them, too, are pouring into our homes by mail, with the request that we purchase the little stickers and so further strengthen the campaign against one of the world's greatest scourges.

This year the Christmas seal comes of age. It is just 21 years since an obscure postal clerk in Denmark conceived the idea of a decorative stamp to be placed on Christmas mail as a means of raising funds for a hospital for tuberculosis children. A few years later the first Christmas seals that were sold in the United States raised $3,000 for the purpose of a sanatorium

Your source of dissolved acetylene becomes not one source but 102 if you use

Prest-O-Lite
DISSOLVED ACETYLENE

THE PREST-O-LITE COMPANY, INC.
Oxy-Acetylene Division
General Offices: Carbide and Carbon Bldg., 30 East 42d St., New York
In Canada: Prest-O-Lite Co. of Canada, Limited, Toronto
31 Plants—71 Warehouses—22 District Sales Offices

A Prest-O-Lite PRODUCT
WORLDS LARGEST MANUFACTURER OF ACETYLENE THE GAS OF A THOUSAND USES
BATTERIES FOR AUTOMOBILES FARM LIGHTING RAILWAY SIGNALS AND RADIO

site in Delaware. Last year 1,250,000,000 seals were printed for the National Tuberculosis Association and their sale brought approximately $4,500,000 into the coffers of the 1500 organizations affiliated with the national body.

During these years the Christmas seal has helped to finance hundreds of local, state and national campaigns, to secure hospitals, sanatoria, clinics and dispensaries. At least, 20,000 public health nurses are at work in the schools and homes to educate children and parents in the rules of healthful living. In this way minor physical defects are detected and, because of early treatment a physical breakdown in later life with tuberculosis or some other serious diseases is often prevented. Every large city nowadays has its open air schools, prevention and nutrition classes where the children of tuberculosis parents and others below par are brought to normal weight and strength. Approximately 3,000 such institutions are in this country at present. This Christmas seal has made possible the Modern Health Crusade, the largest child health movement in the world, through which 8,000,000 school children have been taught daily habits of cleanliness, diet, exercise and rest so that they may develop into robust men and women.

Our participation in the annual Christmas seal sale is an investment in individual and community health. More than that, we become a part of the message of hope which the seal carries to the many thousands who otherwise become victims of a preventable and curable disease. In all truth, the mission of the Christmas seal is joyous health.

MARKING OF GAS CYLINDERS TO IDENTIFY THE CONTENTS

Extract from Proceedings, Regular Meeting, Executive Board, Compressed Gas Manufacturers' Association, Held October 15, 1925, at 2 P. M.

The opinion was expressed that members of the association should give very careful consideration to the resolution adopted by the executive board at the meeting on September 17th, relative to the marking of gas cylinders. It was pointed out that some means of identifying the contents of cylinders was undoubtedly desirable in the interests of safety. Various industrial commissions, and other regulatory bodies, have given attention to this matter and have frequently suggested the use of colors as a means of identifying the different gases. The consensus of opinion of the members of the association shows that there are many objections to the use of colors for this purpose and indicates that there is a general belief that marking the name of the gas on the cylinder is the most effective way of identifying the cylinder contents.

The subject is one considered by those interested in safety to be so important that the suggestion was recently made to prepare a national code for the identification of compressed gas cylinder contents. In connection with this matter representatives of the association stated that they were assured that the industry itself would take active steps towards properly marking cylinders and as a result no further action is being taken at present towards the establishment of a general committee to consider the preparation of a national code.

In view of these facts it was the concensus of opinion of the meeting that it is most important that members of the association take active interest in the marking of cylinders to identify contents.

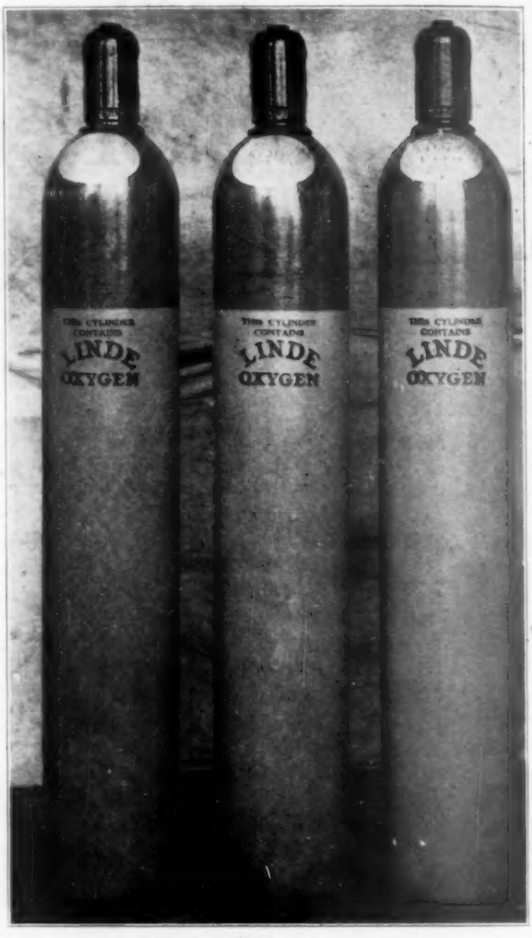
The board voted that this matter be brought to the attention of each member through the News Bulletin and a special circular letter and that members be advised that information concerning suitable means of marking the name of the contents on the cylinder can be obtained from the secretary.

AMERICAN WELDING SOCIETY APPROVES STANDARDS

The committee of the American Welding Society, appointed by the president to report in the matter of blow-pipe and regulators, hose unions, hose union nuts and connections (tail pieces), unanimously suggested that the American Welding Society adopt as their standard for these parts the standard adopted by the International Acetylene Association and the Gas Products Association; and further recommends that members and others be advised to call for these standards on equipments manufactured after January 1, 1926.

TO IDENTIFY CONTENTS OF COMPRESSED GAS CYLINDERS

The necessity of so marking compressed gas cylinders as to plainly identify contents has lead to the adoption of the apparently simple and convenient method of using rubber stamp and suitable water-proof ink for marking contents.



Cylinders Marked to Show Contents

The results of this method have proved entirely satisfactory and its widespread use is anticipated. (See report of C. G. M. A. below.)

The gas cylinders illustrated herewith have had their contents identified by the rubber stamp and water-proof ink method.

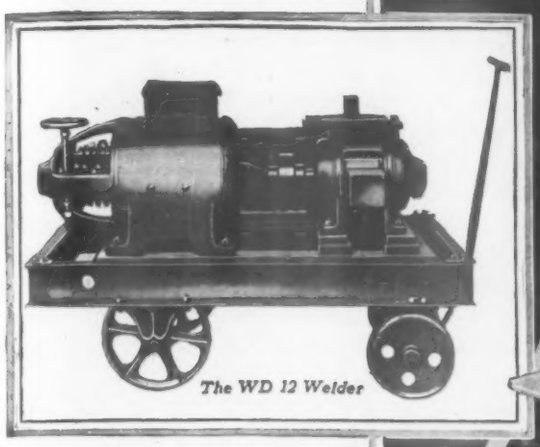
The Fall get-together luncheon of the Compressed Gas Manufacturers' Association held at the Hotel Astor on October 15, proved a very enjoyable affair.

Following the luncheon a meeting was held at which reports of various committees were presented. Necessity of plainly identifying contents of compressed gas cylinders was among the more important subjects covered by reports. Satisfactory progress by the association was shown in the reports.

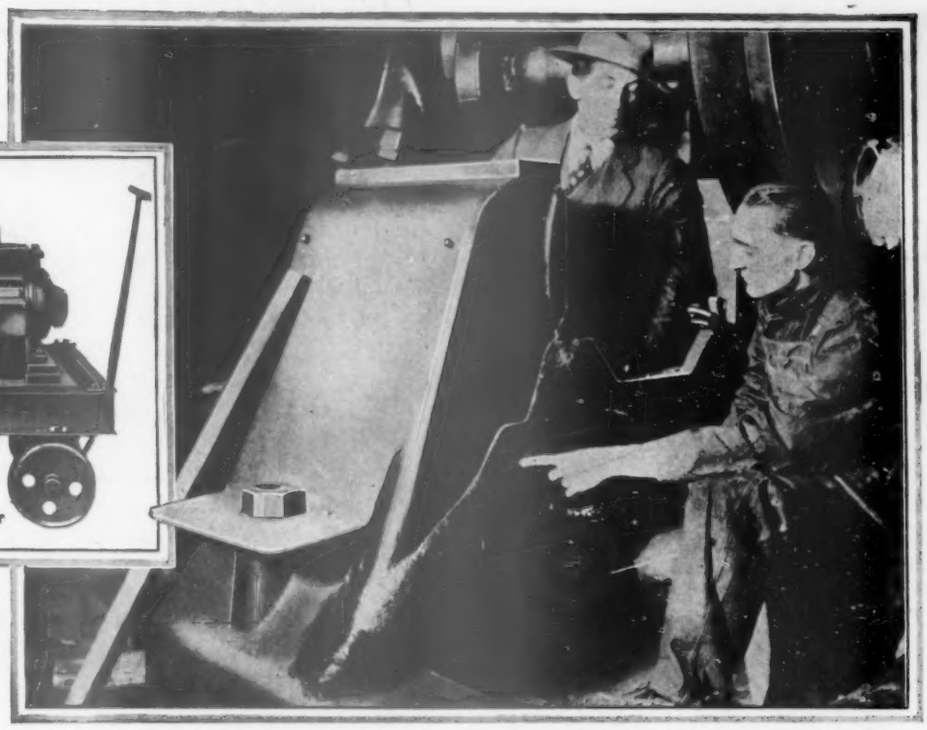
A handsomely engraved testimonial was presented to Past-President A. Cressy Morrison in appreciation of his valued services as president.

DANLEY ACETYLENE GENERATOR

For a couple of years the Danley Welding Station, Lafayette, Indiana, has been perfecting a new type of portable acetylene generator. A number of these have already been made and put in service and it is claimed by the manufacturers that the results are highly satisfactory to the users. The generator is built to operate with cakes of granulated and compressed carbide.



The WD 12 Welder



Broken pillow block of cast iron Ammonia Compressor at the American Trona Corp., Trona, Calif. repaired with a G-E Arc Welder and G-E Welding Electrode.

G-E Arc Welders Save Costly Delays and New Parts

An eight-foot crack—but G-E arc welding repaired it. The job took hours, instead of days or weeks, as would be the case if a new pillow block had to be secured and installed. And, when mended, the weld possessed greater strength than the compressor body.

Arc welding for repairs and emergency construction work eliminates costly delays and prevents dangerous risks. That corroded or worn place on boiler, retort, or pressure vessel can be patched immediately; leaking joints or cracked seams can be mended; a caulking, leak-proof deposit can be welded along the edge of riveted seams.

Speed and Simplicity are favorite characteristics of the G-E Arc Welder. Current is adjusted to suit the work by simply turning a hand-wheel. A reactor automatically steadies the arc. There are many to testify that a G-E Arc Welder soon pays for itself.

The Welding Specialist in your nearest G-E office can advise you.

The G-E line of Arc Welders includes types for all purposes. If you have standardized repetition work in joining or building up surfaces, investigate the G-E Automatic. It is the most economical, most efficient method.

28-15

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES

Welding Solves Boiler Problem

Here Is a Piece of Stationary Boiler Work Done Under Conditions Which Are Quite Commonly Found in the Case of Heating Boilers

ELECTRIC and oxy-acetylene welding equipment are taking the place of hammers, chisels and hard labor.

The contractor on the following job was called upon to reclaim a low pressure steam boiler, which was completely corroded from the mud ring to the first row of staybolts, the area affected being both the complete firebox, wrapper sheet, door sheet and throat sheet.

Speed was an absolute necessity, as is usually the case. The owner was in a dilemna, due to the fact that he could not get a new boiler into the basement without tearing up the sidewalk and foundation of the building, as the boiler was put into the basement some ten years ago, before the carpenters laid the joists for the first floor. (Seemingly an oversight of a good many architects on present day structure.)

Another problem which bothered the owner was the location of the boiler in the basement, one side of the boiler being parallel with the wall too close to permit riveting with any degree of working space. This eliminated a riveted patch job, as it would have been necessary to tear down the brickwork and move the boiler to a position and point where it could have been satisfactorily reclaimed. This, of course, meant delay in getting the boiler into operation.

Now an examination of the photographs will reveal the procedure followed in solving this "boiler problem." The work was done in the shop of the Western Welding & Equipment Company, Chicago.

Photo above shows the water leg cut off, half way between first and second row of staybolts, in firebox and between second and third row of staybolts on wrapper, door and throat sheets.

"To accomplish this," says Mr. Jardine, proprietor of the shop, "we jack up the boiler and tear out only sufficient brick to enable us to do the cutting; we do not interfere with the majority of the walls or arch."

They then haul the deceased member to the shop, where a duplicate section was built entirely of steel, a three-quarter-inch bar being used as a substitute for the cast iron mud ring.

Other photos show the completed new section. The method of making the new section is to lay old section with the mud ring to the ground then tack weld the four firebox sheets to the cut on the old section. Inasmuch as the firebox weld is a butt weld, it saves considerable time out in the field to cut the new sections to conform to the old section cut. Beveling, etc., can be done before the section leaves the shop. This accomplished, the procedure is to take the wrapper throat and door sheets and lay them up to the outside of the old section, outer sheets, allowing an additional inch in depth, for a cap weld. This is entirely satisfactory as it is free from fire hazard and enables the welder to reach into narrow spaces and still get an A1 weld.

Left—Rear View of Completed New Section. Center—Showing Water Leg Cut Off. Right—Front View of Completed New Section

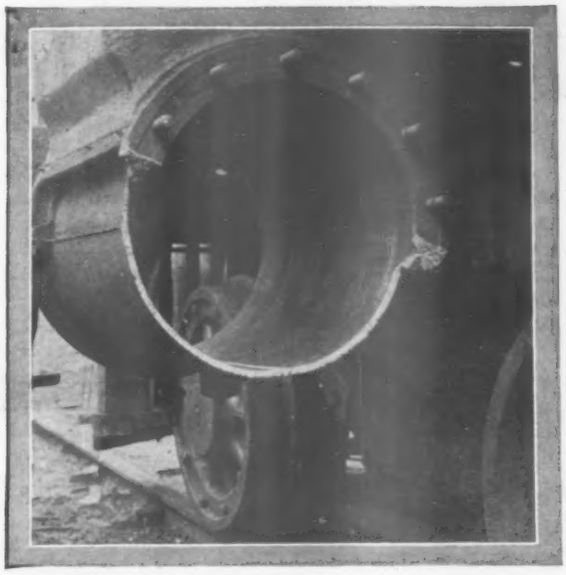
The next operation is to insert the steel bar, or mud ring and weld same, then cut the staybolt holes, first row, insert and weld the staybolts.

To eliminate all possible labor in the field they give the new section a water test before leaving the shop. This completed, they haul the new section back to the job, jack it up into position, weld all joints and connections, cut holes, weld in second row of staybolts, lay the few remaining bricks back into location and the task is completed.

In a short time they have transferred the most severely abused part of the boiler into a twentieth century one-piece welded firebox.

WICKWIRE SPENCER MILL ANOUNCES SIX GRADES OF WIRE

A circular recently published by the Wickwire Spencer Steel Company gives a list of six grades of welding wire to meet the varying requirements of both gas and electric welding. In chemical analysis four of these grades meet the specifications of the American Welding Society, and the other two have been developed for users who have found them more satisfactory for certain classes of work. The general properties of each are enumerated in the circular, and the manufacturers further point out that by operating their own mills they are in a position to control the entire production process, starting with the mining of the iron ore.



Welded with Tobin Bronze without Dismantling

This type of repair to a locomotive cylinder formerly necessitated dismantling the cylinder and pre-heating the casting before the weld could be made.

By using Tobin Bronze, the broken flange was welded in place at a dull red heat, with the Oxy-Acetylene flame, without dismantling the casting, at a great saving in time and expense. And the weld is stronger than the original cast iron.

Tobin Bronze Rods, an exclusive product of The American Brass Company, can be secured from leading Distributors.

Descriptive pamphlet, including table of weights, melting points, also suggestions for welding with Tobin Bronze, sent upon request.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED
New Toronto, Ontario

TOBIN BRONZE
REG. U.S. PAT. OFF.
WELDING RODS

Welded Power Plant Piping*

Simple Designs Are an Aid to Good Workmanship and Welding Accomplishes Savings in Several Directions

By S. W. Moulder†

WELDING of power plant piping has many advantages most of which are relatively applicable whether the system is only partially welded as for example the headers or whether the system is welded as nearly as possible in its entirety. Up to date the great bulk of power plant welding has been fabricated in the shops of regular manufacturers engaged in that work. Some of these same concerns, have, during recent years, successfully carried welding right into the power paint itself by doing pipe line welding on the job. This latter development has grown quite rapidly, in some few cases having been carried to the extent of eliminating, on some lines, practically all fittings and providing flanges only adjacent to valves and apparatus.

The first advantage is lower first cost. I find in a review of the records of this Society on the subject of pipe welding considerable data covering the relative first cost of an individual welded joint as against an individual coupled or flanged joint. I find very little, however, giving the relative over-all cost of fittings and flanged piping.

To illustrate the relative first cost of two simple headers which might be incorporated in the design of any small power plant I am showing Fig. 1 which in the one case illustrates a welded high pressure steam header for a battery of several boilers and with outlets for several connections to turbines, etc. With the dimensions and materials shown on the sketch the cost of this welded header would be $332.00. The other illustration in Fig. 1 is that of a header for the same purpose but made up of the same weight steel pipe with lap joint flanges and extra heavy cast steel fittings. The cost in this case is $1,034.00.

Fig. 2 shows a large low pressure exhaust steam header, in the one case made up welded and in the other case made up with lap joint piping and cast iron flanged fittings. The welded header would cost $269.00. As shown with flanges and flanged fittings, the cost would be $478.00.

These startling differences in price probably explain why there has been a more rapid development of welding in headers and allied work than in other pipe runs in power plant work, since the saving is largely proportional to the number of flanged fittings and joints. Even when fewer joints are involved the saving is still substantial, particularly in view of other advantages to be discussed later.

In the case of Fig. 1, there is also a saving in weight of 2980 lbs. and in the case of Fig. 2 a saving of 3530 lbs., both in favor of the welded headers. This naturally means a relative saving in labor of handling and installation so that the entire saving is not shown simply in difference in price.

These savings in first cost apply to work that is almost invariably done in the shop. The question naturally arises as to whether such savings can be made in field work where the facilities for welding are not so good. The answer to this question is best given by the following figures covering an actual job we installed for a large western manufacturer. This job was the installation of 875 feet of 16 inch O.D. steel pipe installed in a concrete tunnel.

The following shows actual cost as installed with 43 butt weld joints and 20 standard rolled steel flanges, used adjacent to valves and expansion joints.

16-inch O.D. Steel Pipe, ¼ inch thick, 875 feet	$2,062.90
Mill Shipment Freight	153.55
16-inch Standard Weight Rolled Steel Flanges, 20	386.16
16-inch Red Rubber Gaskets, 20	30.00
1 x 4 Bolts and Hex Nuts, 320	53.13
Drums Acetylene Gas, 30	193.20
Drums Oxygen Gas, 45	163.25
Welding Steel, 100 lbs	16.50
Total Cost	$3,058.69

The following shows the actual cost of materials if lap joint piping had been furnished from one of our fabricating plants.

16-inch O.D. Steel Pipe, ¼ inch thick, 875 feet	$2,394.44
Fabricating Plant Cost	
Freight from Fabricating Plant	233.10
16-inch Lap Joints with Standard C.I. Flanges, 88	1,306.80
16-inch Red Rubber Gaskets, 63	94.50
1 x 4½ Bolts and Hex Nuts, 1008	175.02
Total Cost	$4,203.86

The above figures show that in this instance the material fabricated for lap joints and delivered to the job would have cost approximately 37 per cent more than the materials for the job as installed with welded joints.

The actual cost of labor for handling the pipe (through one opening in the tunnel) including the foreman's time, welder's time and fitters and helpers, totalled 440 hours. The foreman who handled the job expressed the opinion that the labor for lap joint piping would have been about the same, but mentioned the fact that the plain end pipe was easier to handle in the tunnel than lap joint piping would have been, due to the fact that the pipe roll supports were placed in position and it was then very easy to roll the pipe through the tunnel on these rollers.

There is also a considerable saving in first cost due to the heavy expense of insulating flanges. With welded piping many flanges are eliminated and a more economical job of pipe covering is obvious. In fact the great difficulty of adequately insulating large flanges often results in their being left uncovered with consequent serious heat losses. In some cases flanges are also left uncovered to facilitate repairs and replacement of gaskets.

The extent of the savings by having a perfectly insulated line have been demonstrated by the engineers of the Super-Heater Co., the record of whose tests, presented before the A.S.M.E., showed that a pipe with bare flanges, but insulated along the body of the pipe lost half as much heat as did a totally bare pipe.

Another economic factor which is particularly apparent in large lines for low pressure work is the saving in weight of the pipe itself. This saving in weight is greater, of course, where screwed flanges are used because often the weight of pipe is beyond what is necessary in order to provide for threads. Where pressure factors are not involved, engineers by specifying welding would of course show a very considerable saving in the class of pipe used. These various factors of fabrication, construction and saving in materials combine to make welding under a great many conditions a very much lower first cost proposition than other types of joints. More important still, these savings are made with an increase of efficiency if the welds specified are properly made.

Perhaps of even greater importance than the money saving,

Extract from paper presented at Fall Meeting, American Welding Society, Boston, October, 1925.

†Chief engineer, Heating, Power and Industrial Piping Division, Grinnell Co., Inc.

where all or part of the welding is done on the job, is the improved service which such procedure allows the contractor to give. If all piping must be fabricated to exact length, as is the case unless welding on the job is done, it means that measurements for a portion of the piping at least cannot be taken unless the apparatus, such as boilers, turbines and auxiliaries are in place and lined up. It is then necessary to order these materials, get them fabricated and ship them often at an extra added expense and with consequent actual delay in time of starting of the power plant.

For the high pressure and high temperature lines where cast steel fittings are usually required another element which has

with the engineer in charge and suggested that he allow us to make welded fittings from pipe instead of reordering the cast steel fittings with all that involved in the way of chance for another defective casting. He agreed and we successfully welded the special fittings. They have given satisfaction for a period of 12 years on a line of 200 pounds pressure and 125 degrees superheat.

Even where cast steel fittings are not required this same element of delay is often present. An example of this is large condenser and exhaust steam piping where the cast iron fittings ncessary almost invariably include some "specials."

In a word, there is in welding a flexibility which not only

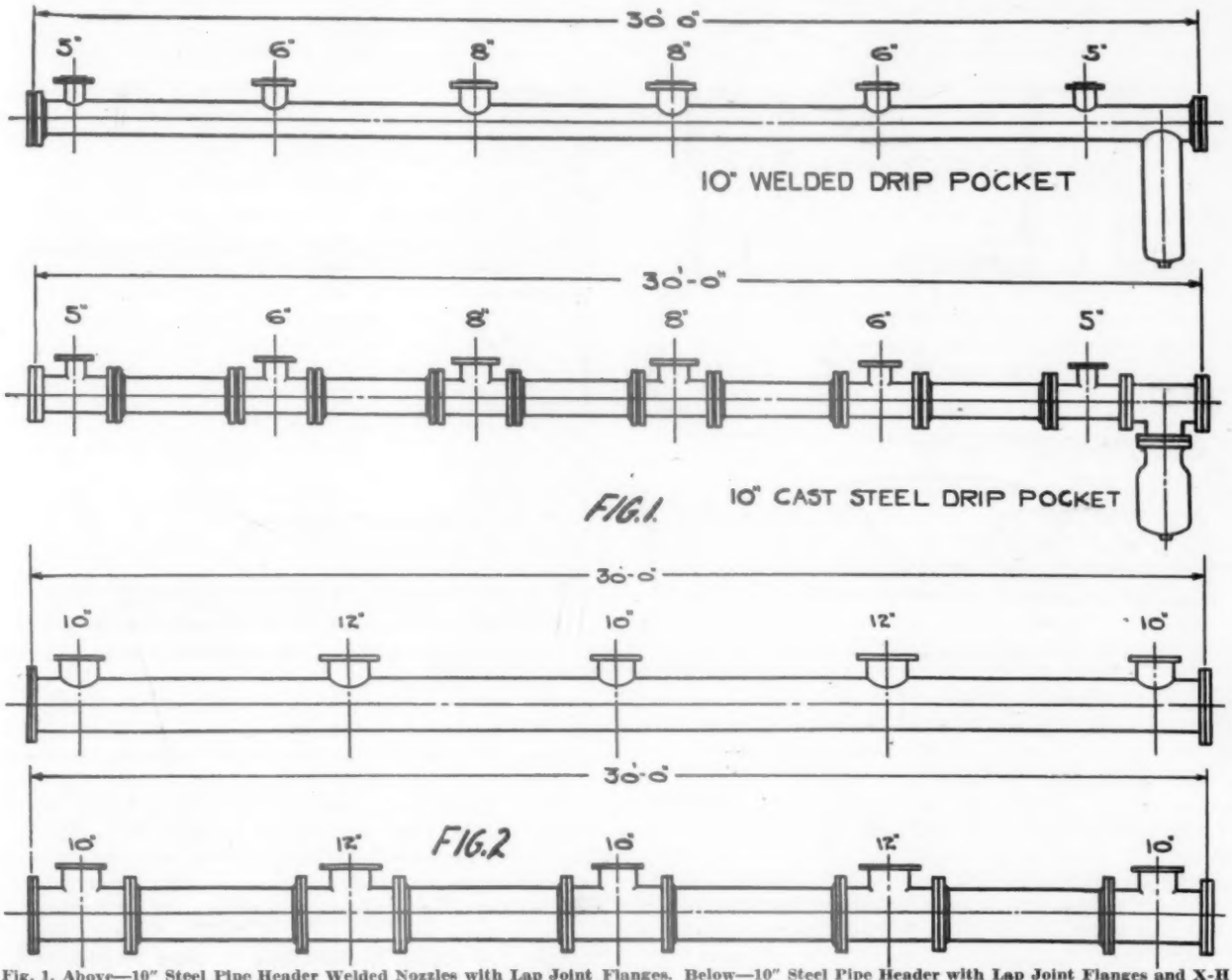


Fig. 1, Above—10" Steel Pipe Header Welded Nozzles with Lap Joint Flanges. Below—10" Steel Pipe Header with Lap Joint Flanges and X-H Steel Tees. Fig. 2—Comparison of Welded Exhaust Header with One Having Cast Iron Flanged Fittings

an important bearing on service enters into the proposition.

As you know the manufacturer of steel fittings and cast steel headers is a somewhat speculative undertaking. The several fittings and headers of this kind required for a given job may be ordered weeks and sometimes months in advance. When finally cast there is always present the possibility that one or more castings will be found defective and will tie up the entire job. Defects in the casting may not become apparent until machining operations are well along and often such defects do not show up until after the material is completely installed and tested. This feature often results in the discovering of defective material at the last moment with delays caused by reorders and remanufacture running to weeks and months.

Perhaps our first experience along this line was in a power job for the Rhode Island Company in Providence where several cast steel fittings were found to be defective after the work was almost entirely completed. We took the matter up

allows piping work to proceed in advance but also which allows many desirable changes to be made in the layout during the process of erection. These two factors combine to make the fabrication of any specification where welding is to be utilized a much simpler proposition than where flanged joints are to be used.

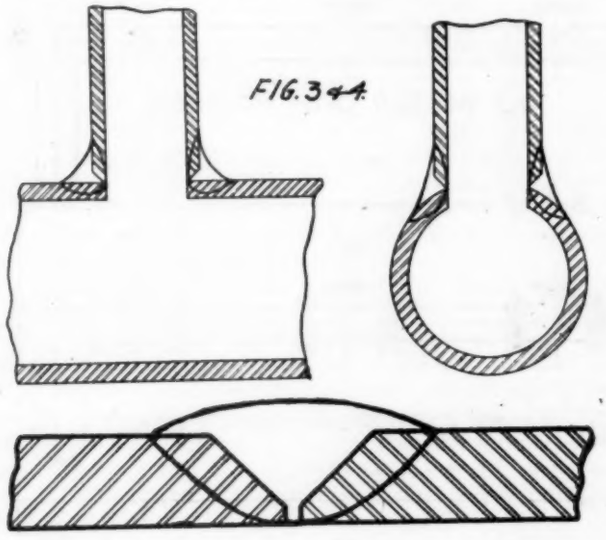
Where welding is being employed in lines and headers it will at once occur to designing engineers and construction forces that the same process can be utilized to greatly simplify the often vexatious problems of anchors and supports. For instance welded shapes can be made as required of flat or structural steel.

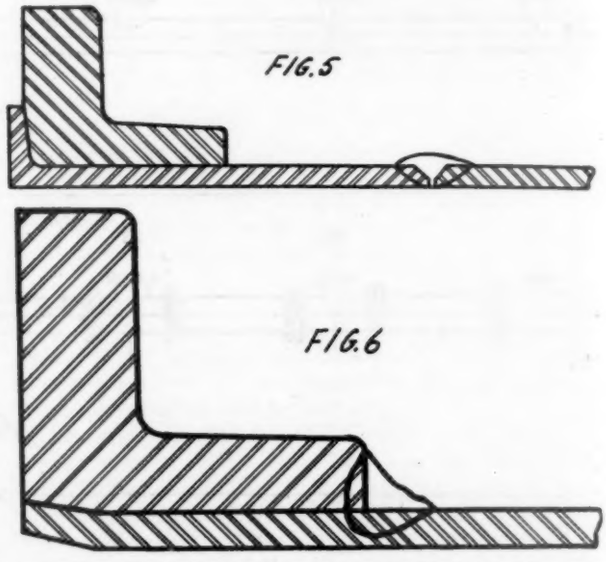
Still another advantage of welding is forcefully illustrated in large exhaust steam and condenser lines. Where these long runs are made with cast iron fittings, the tremendous weight set up becomes a structural problem of importance often involving special provision in the building to support the lines.

Another point very much in favor of welded piping for power plants is of course the fact of a much lower maintenance cost due to leaky joints. Where the power plant is serving industries or communities with power and light the leaking of a single flanged joint may cause shut down which will result in a considerable economic loss to the community. Always providing that the welding is properly done, it can be set down that once so done a joint can be forever forgotten which is certainly not the case with even the best of flanged joints.

All of the foregoing advantages are so real, so obvious and so important that the problem of removing the one single factor that limits their wide extension to the whole field of power plant piping becomes one of transcending importance. As previously pointed out, the single restricting factor is the development and perfecting of some method to assure that absolute dependability of workmanship which is the crux of the situation. Later I have a suggestion to offer to accomplish that desirable end. But before that suggestion can be most intelligently discussed it is necessary to briefly outline the several factors that are involved in this problem of welding workmanship. All workmanship is based on four factors:

1. Proper materials.
   (a) Basically as to their inherent qualities.
   (b) Artifically as to their special preparation for the work involved.
2. Proper tools.
3. Proper methods and instruction.
4. Proper test to see that the failure of the human element does not destroy all the value of the preceding factors.





Figs. 3 and 4—Standardized Preparation of Material for Welding. Fig. 5—Method of Attaching Flange. Fig. 6—Method of Attaching Flange to Pipe Where Lap Joint is Not Available.

1. Materials

In papers previously submitted to this society the selection of proper materials for oxy-acetylene welding has been quite fully discussed. We, therefore, will briefly rehearse only our own experience in order to have this matter clearly in mind.

Considering first the base materials we have found that where steel pipe is the best for the service required, open-hearth steel has given the best and most uniform results. There is less likelihood of tiny pinhole leaks as explained in former papers. In combination with this it has been our experience that nickel steel or other special rod having a strength greater than the base material give the strongest and most uniform welds.

For certain service lines in the power plant some engineers prefer genuine wrought iron pipe. This pipe can be very successfully welded. The filler rod for use in combination with this should be Norway iron or similar composition.

In many sections of the country brass piping is preferred for use on boiler feed lines and certain process piping. This piping can also be very satisfactorily welded. The filler rod for this is entirely dependent on the analysis of the base metal.

After the selection of materials comes their preparation for the actual job of welding. As before indicated, our own experience has thoroughly satisfied us as to the strength and dependability of plain butt welds on pipe runs and the very simplest type of nozzle weld. As a result, we have standardized on preparing materials as shown in the accompanying sketches Figs. 3 and 4.

An experience of nearly 15 years in welding has convinced us that careful preparation of materials in this matter insures a weld as strong as the base material itself, providing, of course, other factors later mentioned are just as carefully observed.

Fig. 5 shows the method of attaching a flange which we believe is the most satisfactory for this class of work regardless of pressures. Where a flange is necessary at all it usaully comes up against a piece of apparatus or valve and the lap joint flange allows a flexibility for connecting which is very desirable. These short lap joint pieces with their flanges can always be furnished in short lengths, with the end already machine chamfered to be welded into the line at any point. This is preferable to a welded flange for another reason. On the larger sizes particularly on account of the great amount of heat necessary to properly melt down the hub of a flange it is very difficult to keep the flange from warping. This means that it is not an easy task to make a tight flanged joint with an ordinary gasket. In our judgment there is little excuse for a welded flange as it has no advantages over the lap joint flange as the latter can be made fully as strong as the pipe itself. Very recently it has been found practical to also make this type of joint with either wrought iron pipe or brass (iron pipe size) tubing. In makng this up of brass tubing it is possible to use cast iron or steel flanges as the flange does not in any way come in contact with the fluid carried in the line. This makes a very much stronger joint than has heretofore been possible with the brass screwed flanges.

Fig. 6 shows the method of attaching a steel flange to pipe where a lap joint is not available. This method is only recommended for low pressures. Its only practical value is

where large sizes of pipe are encountered. The flange can be machined as shown and a semi-lap joint made with an ordinary peen hammer and then a small fillet welded at the back to insure tightnes and some additional strength. If preferred instead of pening the flange at the front a small welded fillet can be substituted.

Fig. 7 shows a type of flanged joint which will be found satisfactory where a welded flange is absolutely insisted upon. This should be a shop-made joint with a full cut taken clear across the fact of the flange after the pipe is welded.

2. Tools

In discussing tools in welding work, we prefer to pass over as matters of individual preference such items as cutting and welding torches, etc., and to briefly describe certain accessories which have been found valuable in our work.

One very valuable accessory of this kind is a set of standard patterns which the welder can use in marking his cutouts on nozzle welds and on all special fittings. The invariable use of these patterns makes certain that the various sections will fit properly. They are time savers and in addition provide for uniformity which we believe cannot be secured by a hit or miss method.

Very little equipment is necessary as a rule in the construction of power piping work for holding the materials in position or for turning of the pipe. It is generally agreed that where practical it is best to turn the pipe that very little welding need be done on the bottom. For the work which is done in the fabricating shop little experience is needed to learn what is necessary in the way of tables and equipment so that the welders can work to best advantage. This is a matter which can safely be left to the shop foreman.

For work on the job as much of it as practical should be done on the floor. Where it is thought advisable simple roller blocks can be furnished for the pipe to rest in so that it can readily be turned. Sketch shown by Fig. 8 indicates a very simple method of making such an outfit with only plank and industrial truck rollers.

After the pipe is placed in the hangers and supports where it is to be permanently located it will usually be necessary to make an occasional joint where the welding will have to be done from the bottom. Apparently no special difficulty has been encountered as a result of this practice where the welder was trained along lines to be indicated later.

Where a but weld is to be made and the pipe is unsupported for a considerable distance from the joint, it is sometimes advisable to use clamps to insure alignment. Sketch shown in Fig. 9 shows a range of several sizes of pipe.

3. Methods and Instruction

With proper materials, properly prepared and essential tools and accessories, we come to the very important matter of methods to be followed by the welder. These methods must be laid down by the Engineering Departments and welders must be instructed in following such methods to the last detail. If the method set up as a standard is not correct, the welder will never be a competent man no matter how conscientious he may be.

While there may be several excellent ways to do the same thing, we have found it best to choose one way and stick to it—so that constant practice may make perfect. For instance; our method of making a plain butt weld is made clear by the following copy of our instructions to foremen:

"Ends to be butted to within $\frac{1}{16}$-inch of closed, then tack them together at two or more points. Commence the weld at a third point and continue to weld around the whole circumference from starting point. It is important that when the welder comes to the point where he has tacked the two ends of the pipe together that this fillet be thorughly remelted in tying into the new weld.

"Bring ends of pipe at bottom of groove to welding heat, puddle and weld ends of pipe before depositing any welding rod and bring both sides of groove to a welding heat as filling of the joint progresses.

"Fill the joint so the thickness of metal shall be one-third times greater than the thickness of the pipe, viz.: pipe $\frac{3}{8}$-inch thick, joint $\frac{1}{2}$-inch thick.

"It is of extreme importance that in finishing the final tie-in weld that the weld already made be heated back on both sides for a distance of two or three inches.

"The joint shall extend beyond the edges of the groove; viz., width of groove $\frac{3}{4}$ inch, width of joint 1 to $1\frac{1}{8}$ inches.

"On large sizes of pipe it s usually advsable and economical to work two welders, one on each side of the pipe.

"The sections of joint as finished are to be hammered with a peen hammer at a red heat to consolidate and give ductility to the metal. Each hammering to cover a circumferencial space of from 1 to $1\frac{1}{2}$ inches."

This same general practice is used in connection with all welds and forms the basis of our training of welders. In regard to this matter of training it may be interesting to know that in our earlier work we attempted to train foremen and steamfitters in the art of welding with a view to having men who were skilled in the trade of steam fitting who could make an occasional weld when required. This practice was found to be a failure as upon testing the welds of such welders they were quite often found to be unreliable. It would seem that a man to make the very highest class welds must keep in practice continually just the same as in any other highly skilled art in which the hand plays a conspicuous part.

4. Test

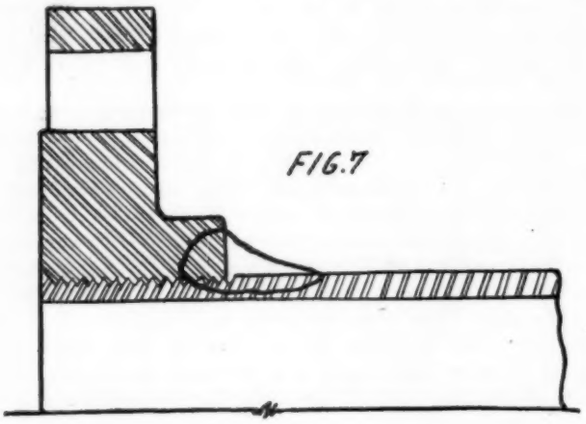
In spite of an established method, careful training in that method and the development of a corps of men who do nothing but welding, our experience indicates that some check on welders must be constantly employed to keep them up to the standard. Our practice in this important matter is to take test pieces in the form of strips cut from the actual work at odd and unexpected times. These specimens may be tested either by bending to a hairpin shape or by pulling. In addition to these tests of routine work, we have also found it valuable where some unusual piece of welding in the field is to be done to give the selected welder special training in the shop where actual field conditions are duplicated as closely as possible. With such special training it is astonishing to see how exceedingly difficult field welding is done simply and easily.

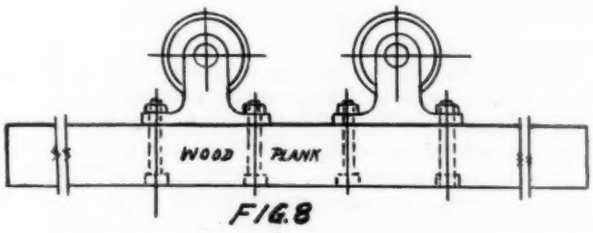
While these periodical tests of the work of individual welders is an essential it is of course no guarantee of the quality and dependability of any large job such as a long welded line or header. Individual testing of this kind does, however, make it possible for fabricating concerns to test all finished work in a way that should establish its dependability.

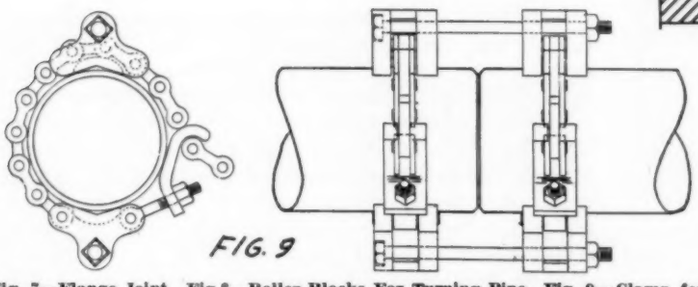
It is now quite generally recognzed that the most reliable test for welded work is what is called the "pressure and impact test." Each section of piping as it is completed should be tested with a hydrostatic pressure at least three times the working pressure in pounds per square inch. While holding this pressure the piping on either side of the weld for a distance of not less than three inches should be thoroughly hammered. This should be done around the entire circumference of the weld. Care should be taken in filling the pipe that a proper vent is placed in the line at a high point so that all of the air can be expelled. If care is not used in this there is a possibility that small leaks may not be detected.

In all of the foregoing no special mention has been made of the class of work which has been frequently encountered in the past few years in connection with so-called "Super-Power" plants which have been and are being built for some of the largest public utilities companies. In this class of work, steam pressures range from 350 pounds upwards with super heat often raising the total temperature as high as 800 degrees Fahrenheit.

In spite of these tremendous pressures and temperatures, it is the writer's belief that any oxy-acetylene weld made in accordance with the methods and standards previously outlined, is a thoroughly practical type of joint for such service. My reasons for this belief is that the weights of pipe used on such a surface provides a factor of safety which is a constant in that the temperatures involved have not yet reached a point high enough to weaken the resistance of the metals. Since welds, made the way we have indicated, are as strong as base materials, why should there be any doubt that a plain butt weld would be entirely sufficient for this high pressure, high temperature service? Reports of what some of the oil companies have done on a very large scale substantiate this belief since they have used plain butt welds in connection with oil piping where pressures and temperatures are as high and sometimes higher than are encountered often in these "Super-Power" stations.







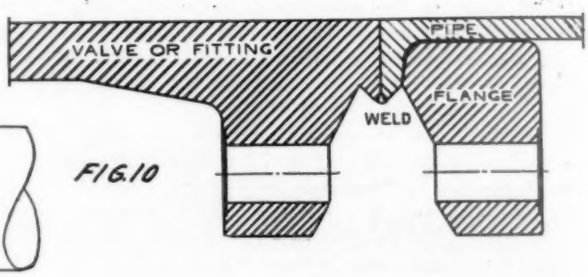


Fig. 7—Flange Joint. Fig.8—Roller Blocks For Turning Pipe. Fig. 9—Clamp for Holding Pipes in Alignment. Fig. 10—Section of a Sargol Joint

In discussing this matter we, of course, must have clearly in mind the tremendous responsibility that rests upon consulting engineers in designing these "Super-Power" stations. Often the comfort and convenience of a whole community may rest upon the normal functioning of these power plants, and it is only right and proper that they should have been extremely cautious in their designs to have provided a type of joint that was dependable beyond question. Certainly it is outside the province of these engineers dealing with public utilities companies to undertake anything in the nature of an experiment. These engineers have, however, by their own specifications, indicated quite clearly that the all-welded line is a very desirable jointed method in this class of work by specifying quite generally what is known as the "Sargol Joint." This joint combines the strength of the ordinary flanged joint with the lasting tightness of the welded joint and frees the line from gasket trouble, which is a real problem where such temperatures and pressures are involved. Fig. 10 shows a section of a Sargol Joint. In this type of joint all of the fittings and valves are made of steel and are fitted with special flanges for welding. Specialties are also obtained with similar flanges. Naturally, the piping system of this type of joint is considerably more expensive than it would be with the all-welded equipment, but public utilities have been quite willing to bear that added expense until such time as they had entire confidence in the ability of welding concerns to produce uniformily a joint as strong as the base material. The one factor in this situation has been the matter of dependable workmanship which this paper has sought to stress wherever possible. The combination flanged and welded type of joint is a safety factor against poor workmanship in welding and its additional expense has been justified in many cases on that account and will continue to be justified until measures are taken which will go far toward guaranteeing the proper kind of welding procedure, including workmanship.

It is the writer's belief that autogenous welding of piping is at the parting of the ways. Either it is going forward very rapidly towards that ultimate goal its obvious advantages entitles it to reach, or it is going to be set back in its progress. Which way it goes depends upon what constructive means can be and are taken to establish it on some standard basis of uniformity. Because such a standard must provide for the very doubtful human factor in the individual welder himself or at least for a high degree of responsibility on the part of his employer, the problem is a complex one.

Simply as an effort to start some constructive movement and to encourage intensive thinking on this problem, which means so much to welding, the writer is bold enough to venture the following suggestion:

On May 19th of this year, at the A. S. M. E. convention at Milwaukee, an informal conference was called by the A. S. M. E. Standardization Committee to consider the evidences of demand for a code on pressure piping. It was the general opinion that a code for this work has become a necessity. It was brought out that this was thoroughly indicated by the fact that the State of Ohio has already taken steps to start formulating a code which within a short time would be ready for legislative action. The opinion that seemed to meet with most popular favor at that conference was that a committee should be appointed to formulate such a code and should work as a subcommittee under the A. S. M. E. Standardization Committee and the A. S. M. E Boiler Code Committee. It was felt that if the A. S. M. E. should agree to formulate a code of pressure piping for national adoption that legislative action by the individual states could be temporarily forestalled.

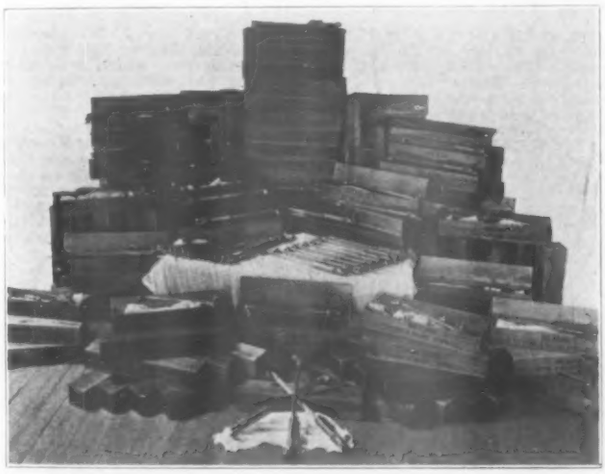
I am bringing this out because at that conference the question of welding seemed to be one of the main points of contention and was thoroughly discussed pro and con. It is only a question of time until such a committee will become active and the legislatures will adopt their code just as the A. S. M. E. Boiler Code has been adopted in most states.

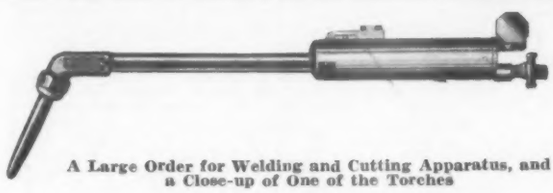
When that Code on Pressure Piping becomes a reality, welding will go forward or sink below its present level in proportion to the way that Code treats welding. In order that welding may be favorably handled in that Code, isn't it necessary that first of all this society develop a rigid specification covering welding? Shouldn't that specification not only cover materials, welding procedure, test of finished work, but also set up a definite plan of action looking toward rigid licensing of those manufacturers whose shop and field methods and whose integrity and responsibility are such as to warrant their being publicly recognized to do such important work?

LARGE CONTRACT PLACED FOR WELDING AND CUTTING APPARATUS

A sign of increased activity in the industrial world is to be found in a substantial contract placed for oxy-acetylene welding and cutting equipment with The Alexander Milburn Company, of Baltimore, Md.

The contract consisting of 119 torches, included among others, a number of Milburn "Cut-Weld" combination cutting and welding torches. The Combination torch, illustrated, makes a strong appeal from an economy standpoint. The contract recently placed is said to be the culmination of years of tests with both combi-





A Large Order for Welding and Cutting Apparatus, and a Close-up of One of the Torches

nation and single purpose torches, which showed a saving of labor and gas in changing from welding to cutting, as well as a decided saving in gas consumption over an extended period of operation.

With a single purpose torch 5 minutes or longer is required to change from welding to cutting or vice versa. In addition the gas in the torch and in the hose back to the supply valve is wasted every time torch connections are changed.

The Milburn Cut-Weld torch is transformed instantly from a cutter to a welder by a mere change of the tip. All mixing occurs in the tip and as hose connections are not disturbed, no gas is wasted.

NEW SEAM WELDER

A new electric resistance seam welding machine has recently been put on the market by the American Electric Fusion Corporation, Chicago, Illinois. The machine was originally designed for welding the longitudinal seams in milk and ice cream cans. It may be used, however, on any work within its capacity which includes clean stock not galvanized up to two pieces of 16 gauge metal, either a lapped or scarfed form of joint being used. According to the thickness of the thickness of the work, it is claimed that this welder will produce from 10 to 15 feet of finished seam a minute and that any length of seam up to 30 inches can be welded. The lower electrode of the machine is a straight copper board and the upper electrode a copper wheel or roller. The roller is held to the work by spring pressure variable at will and is automatically raised from the work by air pressure at the stroke. The stroke may be varied by means of stops which can be set automatically. A weld is made both on the forward and backward strokes thus making the machine double acting.

NEWS OF THE WELDING TRADE

D. E. Cunningham has been appointed purchasing agent of the Welding Service and Sales Co., Flint, Mich.

A new oxygen plant is being constructed in Roanoke, Va., by Linde Air Products Co. It is reported that oxygen will be piped from the plant to the shops of the Norfolk & Western Railroad and the Virginia Bridge and Iron Works.

The plant of the Vinn Motor Truck Co., Philadelphia has been acquired by Morris, Wheeler & Co. of that city, who are planning to move their business to the new location.

A one-story addition is planned for the factory of the Oxweld Acetylene Company, Jersey City, N. J.

The sale of the Tulsa Oxy-Hydro Co., Tulsa, Okla., to the Union Carbide & Carbon Corporation, New York, was recently reported.

A. J. Russell, Bettendorf Oxygen-Hydrogen Co., Bettendorf, Iowa; Walter Brant, Indiana Oxygen Co., Indianapolis, Ind.; Stanley Winger, Gas Products Co., Columbus, Ohio; and O. E. Engler, The Balbach Co., Omaha, Nebr., were visitors in Chicago, Oct. 20.

F. C. Heppel, formerly sales manager of the Tulsa Oxy-Hydro Co., has recently joined the Bain-Beaird Company organization in Shreveport, La.

E. L. Essley Machinery Co., Milwaukee, have been appointed exclusive distributors in Wisconsin for N. A. Strand & Co., Chicago.

Geo. D. Purdon, district manager of Commercial Acetylene Supply Co., in Chicago, was recently appointed a member of the 1925-26 Committee on Public Safety and Motor Traffic of the City Club of Chicago.

The John A. Roebling's Sons Co., Trenton, N. J., is making plans for the erection of a new two-story plant in San Francisco.

Ralph R. Browning has been elected president of the Oxweld-Acetylene Co. and the Union Carbide Sales Co., New York, of which companies he previously had been vice president. He has been elected vice president of the Linde Air Products Co. in charge of all sales activities. He has been elected vice president also of the Prest-O-Lite Co., Inc. Mr. Browning's headquarters are at 30 East Forty-second street, New York.

A one-story addition is planned for the shop of the Atlas Welding Co., 1421 Adams street, Hoboken, N. J.

It is reported that the Youngstown Welding Co., Youngstown, Ohio, manufacturers of truck tanks, will build a 70x200 feet plant.

A new aluminum-graphite plant has been added to the list of products of the Joseph Dixon Crucible Co., Jersey City, N. J.

W. R. Boyd, formerly of Burke Electric Co., Erie, Pa., recently established a new commercial welding shop in that city.

At the last meeting of the board of directors of the Linde Air Products Company, G. W. Mead, formerly president, was elected chairman of the board. W. F. Barrett, formerly vice president, was elected to the presidency.

In addition to these changes R. R. Browning was elected vice president in charge of sales activities, and J. A. Rafferty, vice president in charge of engineering, manufacturing and research.

At a recent meeting of the board of directors of the Prest-O-Lite Co., Inc., M. J. Carney, formerly president, was elected chairman of the board. William F. Barrett, formerly vice president, was elected to the presidency. Ralph R. Browning was elected vice president in charge of acetylene sales activities. R. J. Hoffman was re-elected vice president in charge of storage battery and automotive divisions.

George J. Mohr, formerly manager of the Purox office in Pittsburgh, has organized the Mohr Welders Supply Company, located at 314 Twenty-ninth street, Pittsburgh, Pa. Mr. Mohr will distribute, in the Pittsburgh territory, the products of the Purox Company.

Dean K. Chadbourne has been appointed general manager of the Westinghouse Electric International Company to succeed E. D. Kilburn, who was recently elected vice president of the Westinghouse Electric and Manufacturing Company, according to announcement from the Westinghouse International Company's headquarters.

Edward D. Kilburn, vice president and general manager of the Westinghouse Electric International Company, and Walter S. Rugg, general sales manager of the Westinghouse Electric and Manufacturing Company, were named vice presidents of the latter company at a recent meeting of the board of directors in New York. At the same time Richard B. Mellon of Pittsburgh, president of the Mellon National Bank of that city and a brother of A. W. Mellon, secretary of the United States Treasury, was elected a director of the company. Mr. Mellon will fill the vacancy caused by the death of William McConway, formerly president of the McConway & Torley Company.

On October 31, 1925, H. W. Carter severed all connection with the Carter Welding Company of Toronto, Ltd. Peter Sorley will continue to direct the company as in the past.

The Fibre-Metal Products Co., Chester, Pa., announce that they offer to those having suitable specialties the manufacturing facilities of their large new factory, which is especially equipped for light manufacturing.

CURRENT WELDING LITERATURE

ECONOMICAL REPAIRS BY WELDING, by A. M. Candy. One great economy of the arc welding process is the fact that it accomplishes repairs which have been considered impossible. Spindles worth several hundred dollars are repaired at a cost of $25.00 to $50.00. Pinions worth $2,400 are repaired at a relatively small cost. Engine cylinders and rolling stock offer further uses for welding. The author recommends a centralized welding department where the work can be brought for repair with a portable unit to use when it is necessary to take the welder to the job.—Iron Age, November 12th.

CUTTING HEAVY GAUGE AND RISERS.—The oxy-acetylene cutting process removes all limitations from the matter of gating and heading up castings. Risers can be made as large as desired because of the ease of cutting them off. Piping the gases eliminates the necessity for carrying cylinders through the buildings and centralizes the responsibility for cylinder handling. Considerable gas is saved by carefully cleaning the riser necks before cutting. It is aso advisable to arrange the work so the operator can work as long as possible on cuts of the same size.—Foundry October 1st.

WELDING FOR THE PLUMBER, by H. A. Woodworth. A discussion of the advantages of the welding process for both installation work and repair work. The substitution of welded joints for old fashioned pipe joints for domestic use is becoming common practice in larger cities. The author gives several tables showing the cost of welding several types and sizes of joints as compared to the cost of ordinary fittings.—Domestic Engineer, October 17th.

THE ADAPTABILITY OF ELECTRIC ARC WELDING TO THE FABRICATION OF STRUCTURAL STEEL, by A. G. Bissell.—Description of a series of tests made to obtain some new facts regarding the efficiency of arc welding as compared to riveting. From the tests is was determined that arc welded joints in structural steel members proved strong enough to remain intact while the structural steel members were badly deformed under a load of forty tons. When subjected to vibration of 1760 reversals per minute arc welded joints surpassed standard riveted joints in permanence and showed a longer life than the structural materials which they joined. Under a sudden blow of approximately 700 tons the arc welds did not fail even though the structural steel members were severely strained and deformed. It is estimated that the cost of welds similar to those used in the tests will be about 15c to 20c per foot of welding.—The American Architect, October.

WHAT OCCURS DURING OXY-ACETYLENE CUTTING OF STEEL, by S. W. Miller. Heavy billets should be preheated to a dull red before cutting to avoid stresses set up in the cutting edge. The heat affected zone may contain minute cracks and should be removed, preferably by machining if the piece is to be subjected to heavy service stresses. Annealing or other heat treatment should be done after the cutting and before machining. These precautions are not necessary when cutting boiler plate or other material having a carbon content of less than .35 percent.—Acetylene Journal, November.

PREPARING THE JOINT FOR WELDING.—Beveling is necessary principally to insure penetration. The angle of bevel depends on the size of the piece and the skill of the operator. Thick pieces should always be beveled on both sides if it is possible to work from both sides. No beveling is necessary on aluminum less than ¼ inch thick. The part should also be well cleaned before welding. When set up allowance must be made for contraction.—Acetylene Journal, November.

HOW TO WELD STEEL SMOKE STACKS.—The procedure on this work is practically the same as any light steel tank job. The instructions for carrying out the work cover the selection of material for the stack, the choice of the welding rod, the design of the joint, the welding procedure and the assembly of the different parts of the stack.—Acetylene Journal, November.

UNDER WATER CUTTING BLOWPIPES, by D. Richardson. A description of recent developments in the construction of torches for under water cutting.—The Welding Journal, London, October.

WELDING OF ORNAMENTAL IRON can be performed for all forms of welding in ornamental iron work. This work includes steel stairs, doors and door frames, fences, lamp posts, ladders, pipe rails, shoots, gratings, racks and shelving. The welds are usually small and must be of full strength. Appearance counts for a great deal so that grinding and finishing of exposed joints is often necessary.—The Welding Journal, London, October.

AN OUTLINE IN OXY-ACETYLENE WELDING, by Lionel Johnson. A description of the procedure followed in training welders in the Michigan State Automobile School of Detroit. The course includes welding sheet, steel, brazing, welding castiron, aluminum puddle welding, flux welding and cutting.—Journal of the A. W. S., September.

GROWTH OF THE WELDING INDUSTRY, by J. W. Meadowcroft. A review of the progress of welding during the past ten years. The rapid advance of the welding arc which was made during the World War. Many concerns today have welding research men to study the possibilities of welding in their production program.—Journal of the A. W. S., September.

ARC WELDING COSTS, by K. R. Hare. The amount of metal deposited per hour increases steadily as the size of the electrode is increased and the quality of the weld is improved if flux coated electrodes are used. The temperature of the arc remains constant regardless of the size of the electrode. The cost of electrically welded joints are lower than the cost of riveted joints and it is claimed that the efficiency of the welded joints is considerably higher.—Journal of the A. W. S., September.

ADVANCEMENT IN THE GAS CUTTING OF METALS, by A. S. Kinsey. Earlier uses of the cutting torch were merely for the purpose of reducing big pieces of steel to scrap size but it has been found that the torch could accomplish much finer results. This led to the study of efficient methods of handling the torch and to the perfection of mechanically operated cutting torches. Later research has shown the marked increase in efficiency which results from using high purity oxygen.—Journal of the A. S. W., September.

TRAINING OF OPERATORS AND THE METHOD OF TESTING WELDS IN THE RESISTANCE PROCESS, by H. A. Woofter. In the resistance process the training of operators is a very minor factor as excellent results are obtained with inexperienced help. The welds themselves are easily tested by taking samples and testing them to destruction.—Journal of the A. W. S., September.

OPEN NOTCHES WITH GAS LANCE, by E. E. Thum. Hard holes at open hearth and blast furnaces present no tapping difficulties when oxygen is employed. The lance is also used to drain, soaken and to loosen frozen ladle stoppers. A minimum amount of equipment is recommended for safety and economy. High oxygen pressure in the lance pipe is not necessary so a regulator should always be used. A flexible rubber hose is better than an armored hose.—Iron Trade Review, September 24th.

FIRE TANKS WELDED, by Charles Seitz. A recent application of welding is in connection with the gravity tanks used with automatic sprinkler system for office buildings.—Iron Age, November 5th.

THE SUPREME TEST OF WELDED JOINTS.—Description and photographs of a serious crown sheet failure which occurred on the Canadian Pacific Railway in Western Canada. This was a serious explosion and the illustration shows how the welds remained intact while the solid plate tore.—The Boilermaker, October.

WELDING IN SHIP REPAIRS.—Weding can be employed extensively in ship repairing particularly in situations where the load giving point the welded joint is small. It is also true that welding has been successfully used in parts where great strength is required. The ship yard manager with a couple of well trained operators will soon find that they can be used on a wide range of jobs.—Industrial Gases, London, September.

HIGH STRENGTH WELDS, by J. R. Dawson. Two types of rods for producing high strength welds are the nickel steel rod and the high test rod. The latter contains .20 percent carbon,

.80 percent manganese and .55 percent silicon. Several advantages are claimed for this new rod among them a marked increase in the speed of deposition and decrease in the cost of welding.—Journal of the A. W. S., October.

CONTROL OF MANUFACTURE AND ACCEPTANCE TESTS OF WELDING RODS, by H. M. Carter. In the past too little consideration has been given to the choice of welding rod. The tendency now is to manufacture welding rods to very rigid specifications. Testing of welding rods for special qualities is a very exacting operation.—Journal of the A. W. S., October.

WELDING WIRE A FACTOR IN GOOD WELDING, by C. A. McCune. A discussion of the importance of all classes of welding, pointing out that an excellent result should always be sought in welding operations. Methods of testing welding wire with the oxy-acetylene flame and with the electric current.—Journal of the A. W. S., October.

METALLIC ARC WELDABILITY OF FERROUS METALS, by C. J. Holslag. The chief problem is to shield the molten metal from contact with the air and this is accomplished by the use of a flux or slag coating. There is no pure iron or mild steel that cannot be arc welded but the easiest to weld is mild steel. Nickel alloyed with steel helps to prevent loss of carbon and addition of chromium is further helpful. Manganese is fairly easy to deposit silicon in steel and ordinarily does not cause any difficulty. Cast iron can be welded cold.—Journal of the A. W. S., October.

THERMIT WELDING DEVELOPMENT, by J. H. Deppler. The quality of thermit welds has been considerably increased and the cost of making these welds has been lowered through improvements in the methods of operation which have recently been developed. One of the most important improvements has been the elimination of cleavage planes which were sometimes found in thermit welds made by the older methods.—Journal of the A. W. S., October.

DESTRUCTION TEST ON GASOLINE CRACKING STEEL.—Description of a bursting test made on a tank 10 ft. 6 in. long by 5 ft. inside diameter the shell being 2½ inches thick and consisting of four plates welded together with four vertical welds. A piece was blown from the head of the tank at a pressure of 4700 pounds without disturbing any of the welds.—Journal of the A. W. S., October.

ARC WELDING AS A MANUFACTURING PROCESS, by H. M. Hobart and W. Spraragen. A discussion of the fundamental considerations involved in the use of arc welding in manufacturing and a description of a large number of products which have been successfully fabricated through the use of arc welding.—Journal of the A. W. S., October.

BUTT WELDING MULTI THROW CRANKS.—How an electric resistance weld is used in conjunction with lathe operations to simplify the production of six-throw cranks requiring greater accuracy. The cranks are welded together after the pins have been turned. The method outlined makes it possible to use inexpensive forging dies and produces twenty-four cranks in eight hours.—Machinery, November.

WELDING AIDS BUILDERS OF AMMONIA EQUIPMENT, by H. L. Burkhart. The use of electric welding enables the manufacturer to furnish tighter and stronger apparatus and also simplifies manufacturing processes. The only objection encountered is that insurance companies have not yet obtained sufficient data to warrant them in accepting welded vessels for insurance.—Power Plant Engineering, November 1st.

AUTOMATIC ARC WELDING IN TANK CONSTRUCTION, by W. L. Warner. Automatic hand welding tests on hand and automatically welded tanks. Factor of safety. Specifications for the design of welded tanks.—American Machinist, October 29th.

ELECTRIC ARC WELDING IN RAILROAD WORK, by C. J. Holslag. Electric welding received its first commercial application in railroad shops and is now used for putting back into service anything of metal that wears out or fails. Cost data on both welding and cutting jobs show big economies which can be obtained by using the electric arc to its full capacity.—Railway Purchases and Stores, October.

PROCEDURE CONTROL IN WELDING A STORAGE TANK.—A summary of considerations involved in fabricating a tank of $\frac{3}{16}$ inch plate to hold 1500 gallons of fuel oil under gravity pressure. Checking the welder's selection and inspection of material. Preparation of the parts for welding. Welding technique. Testing for pin holes and leaks.—The Boilermaker, September.

Position Wanted—By all around gas and electric welder. Experienced in operating own shop. South or southwest location preferred. Address 77, care The Welding Engineer.

For Sale—200 Ampere General Electric Welder direct connect, 220 volt motor, good condition. Address Lester Linn, Rocky Ford, Colo.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of THE WELDING ENGINEER published monthly at Chicago, Illinois, for October 1st, 1925, state of Illinois, county of Cook——ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared H. S. Card, who, having been duly sworn according to law, deposes and says that he is the ? ? of THE WELDING ENGINEER and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, THE WELDING ENGINEER PUBLISHING COMPANY, Chicago, Ill. Editor, W. W. Brothers, Evanston, Ill. Managing Editor, H. S. Card, Chicago, Ill. Business Manager, H. S. Card, Chicago, Ill.

2. That the owner is: (If the publication is owned by an individual his name and address, or if owned by more than one individual the name and address of each, should be given below; if the publication is owned by a corporation the name of the corporation and the names and addresses of the stockholders owning or holding one percent or more of the total amount of stock should be given.) THE WELDING ENGINEER PUBLISHING COMPANY, Chicago, Ill. G. H. Mackenzie, Chicago, Ill. M. J. Hungerford, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is. .....(This information is required from daily publications only.)

H. S. Card, Business Manager.

Sworn to and subscribed before me this 29th day of Sept., 1925.

William Derzbach, Notary Public.

(Seal) (My commission expires April 7, 1929.)

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Wanted—Salesman to sell track welding materials, bonds and apparatus to railways. Preferably man having acquaintance in this field and capable of demonstrating when necessary. Headquarters in New York. Address 76, care The Welding Engineer.

Position Wanted—Graduate of Carnegie Tech. Welding Course desires a position in the Pittsburgh district, cutting preferred. Address Irving Lubin, 1832 Locust Street, Pittsburgh, Pa.

Position Wanted—Acetylene welding foreman; can furnish 4 years' references as foreman in large steel plant in Pennsylvania; 10 years' experience. Address 74, care The Welding Engineer.

Position Wanted—Fully experienced blacksmith and welder, oxy-acetylene and electric-arc process. Experienced in machine and job shop work. Prefer northwestern states. Address 75, care The Welding Engineer.

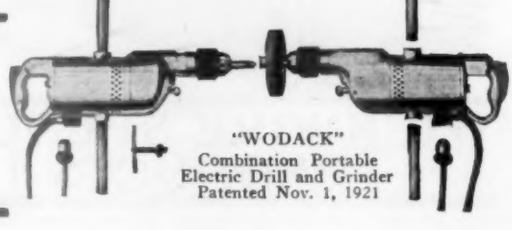
Used WODACKS are "Not for Sale"

The WODACK Combination Portable Electric Drill and Grinder is used by hundreds of welders. It makes hard jobs of drilling and grinding easy, and it helps welders make bigger profits. They all say the same thing about it, "I just wouldn't part with my WODAK if I couldn't get another one." If you don't own a WODACK, ask us to tell you all about it.

Write for our booklet "Electric Tool Facts."

Wodack Electric Tool Corporation

43 S. JEFFERSON ST., CHICAGO, ILL.



"WODACK"
Combination Portable
Electric Drill and Grinder
Patented Nov. 1, 1921

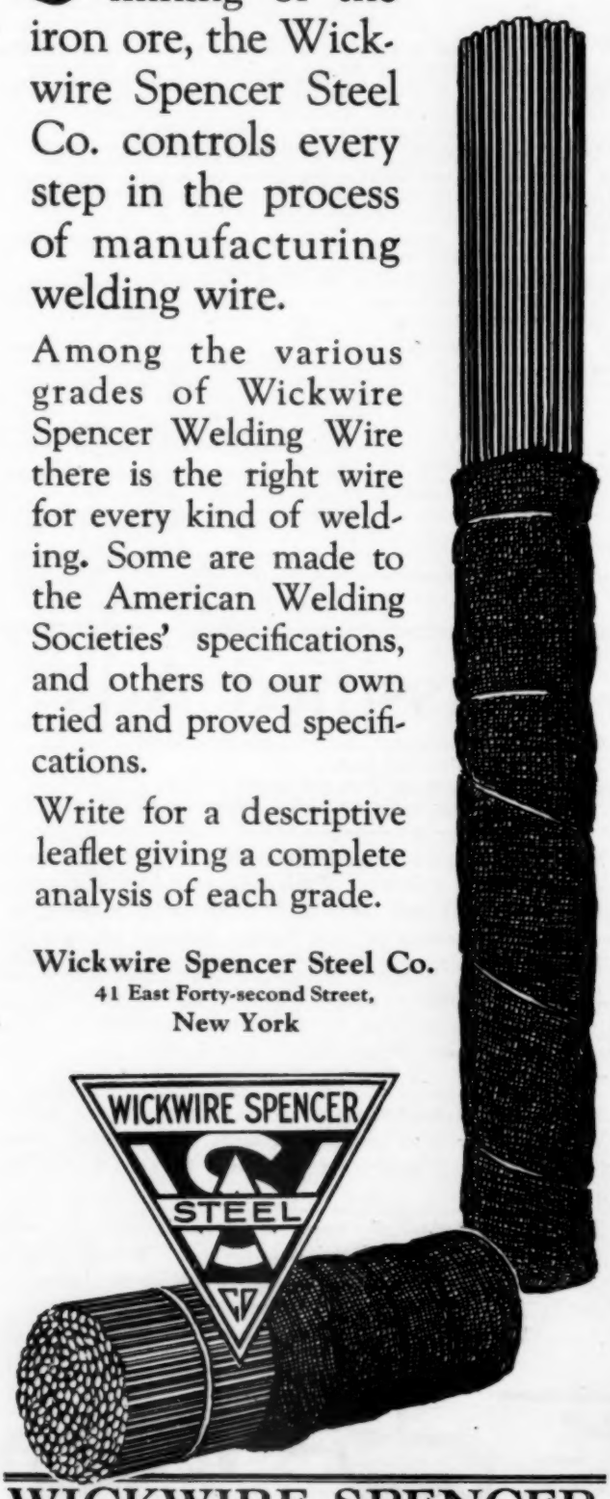
WICKWIRE SPENCER WELDING WIRE

STARTING with the mining of the iron ore, the Wickwire Spencer Steel Co. controls every step in the process of manufacturing welding wire.

Among the various grades of Wickwire Spencer Welding Wire there is the right wire for every kind of welding. Some are made to the American Welding Societies' specifications, and others to our own tried and proved specifications.

Write for a descriptive leaflet giving a complete analysis of each grade.

Wickwire Spencer Steel Co.
41 East Forty-second Street,
New York



WICKWIRE SPENCER PRODUCTS

THE Fibre-Metal Products Co.
CHESTER, PENNA.

Manufacturers of

BOWERS
Patented

WELDING HELMETS
HAND SHIELDS
ELECTRODE HOLDERS

(Metallic and Carbon)

High quality and serviceability have caused Bowers' Helmets and Hand Shields, since 1914, to enjoy largest sales.

The new home of these products is a modern, splendidly, equipped factory with 400% increased capacity.

We offer our unexcelled facilities for light manufacturing to those having suitable specialties.

LIQUEFACTION PLANTS
FOR THE PRODUCTION OF
OXYGEN—NITROGEN
FURNISHED IN ANY CAPACITY FROM 70 CUBIC FEET PER HOUR UPWARDS

HEYLANDT SALES COMPANY
OTTO ADAMS, General Manager
140 South Dearborn Street, CHICAGO

WELD RIGHT BRAZE RIGHT with HOXITE

HOXITE
THE FLUX FOR ALL METALS

Aluminum
Cast Iron
Malleable Iron
Brass
Government Bronze, Etc.

Makes shape welding easier
Makes vertical welding easier

No frothing,
No blow off,
No disagreeable fumes.

PRICE $1.00 PER POUND

THE HOXITE COMPANY
62 SUMMER ST., STAMFORD, CONN.

WELD RIGHT BRAZE RIGHT with HOXITE

Men who wear Wellsworth Welders with Noviweld lenses are always on the job—no lost time on account of sore eyes.

WELLSWORTH WELDERS

The lightest and most comfortable goggle obtainable.

Wellsworth Welders with Noviweld Lenses

Positive Protection from Injurious Light

Noviweld lenses in Wellsworth Welding goggles absorb 99 9/10% of the dangerous Ultra-Violet rays and 97% of the injurious Infra-Red rays. They are guaranteed by the Wellsworth Scientific Laboratories to have these protective qualities.

The color of a lens does not indicate its protective qualities. Be sure you know goggles actually protect before they are allowed in your plant.

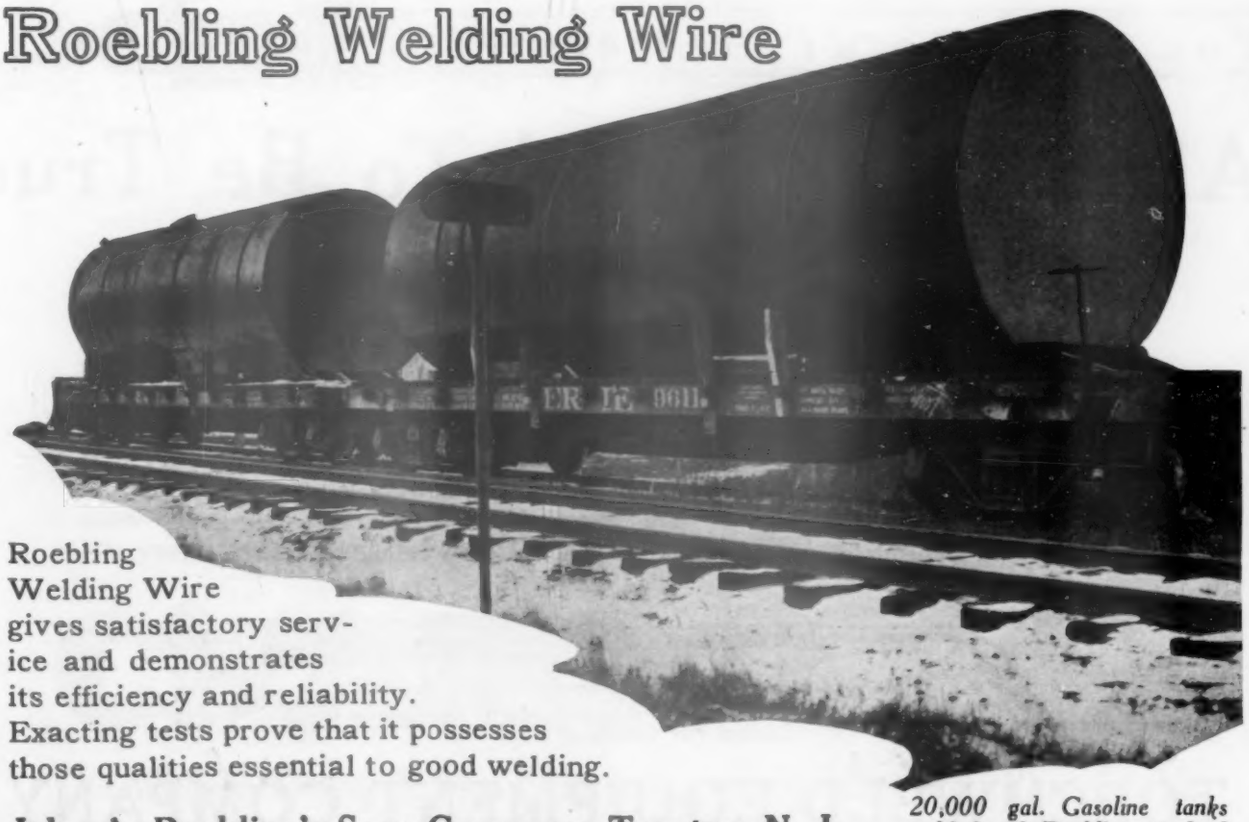
WELLSWORTH SAFETY GOGGLES

American Optical Company

Factories at Southbridge, Mass.

NEW YORK, 70 West 40th St. ST. LOUIS SAN FRANCISCO KANSAS CITY CHICAGO, 10 So Wabash Ave. ATLANTA

Roebling Welding Wire



Roebling
Welding Wire
gives satisfactory service and demonstrates
its efficiency and reliability.
Exacting tests prove that it possesses
those qualities essential to good welding.

John A. Roebling's Sons Company, Trenton, N. J.

20,000 gal. Gasoline tanks welded with Roebling standard bright electric welding wire.

SWEDOX

WELDING RODS, WIRES and ELECTRODES

SEND FOR TESTING SAMPLE

We want every welder in the country—big or small—to be convinced of the ***specialized superiorities*** of SWEDOX products. We know that a trial ***will*** convince you. Hence the free offer. Try SWEDOX on your next welding job at our expense.

No matter what the job is, there is a SWEDOX product especially made for it. We sought and obtained from the nation's expert metallurgists and welding engineers the best analysis for each task. Science has put into SWEDOX rods and wire the proven betterments that make them the recognized standards in every case.

You'll find SWEDOX products free from impurities, uniform in analysis and therefore economical because their use reduces the cost of application and of machining.

We'll send you a sample, at our expense, enough for a thorough test—one which should prove to you, as thousands of welders know, that SWEDOX products are the standards.

SWEDOX booklet describing the products and their uses in detail, will gladly be sent upon request. Address department 4.

CHICAGO, ILL.
4545 S. Western Blvd.
Lafayette 8500

Central Steel & Wire Company

DETROIT, MICH.
5001 Bellevue Ave.
Lincoln 6780

You Can Do It Better With TORCHWELD

Almost Too Good To Be True

So Torchweld Products seem to those who use them for the first time.

Torches, either welding or cutting, that stay on the job until it is done—

Regulators that furnish the gases in constant volume, predetermined by the job and the tip selected to do the work—

Accessories and Supplies of first quality, carefully selected to fit the requirements of the work—

All go together to give results that surprise the uninitiated and please the more experienced.

Torchweld Dependability stands between you and gas welding and cutting worry.

Made in 8 sizes—A size for Every Welding Purpose.

Send for Catalog 23-E

TORCHWELD EQUIPMENT COMPANY

224 North Carpenter Street - - CHICAGO, ILL.

"Delivered in Oxeco Seamless Monolithic Filled Cylinders"

The above specification on your next order for acetylene means that you will receive acetylene in cylinders that are made in accordance with the best known practice of the industry.

The Oxeco seamless shell is the perfect, one-piece container. Every step in its manufacture is under absolute control.

Monolithic filler is accepted by leading acetylene companies as being the perfect porous material for use in acetylene cylinders. Acetylene users should specify deliveries in cylinders of this type.

KEITH DUNHAM COMPANY
110 SO. DEARBORN STREET, CHICAGO

Cramp's Welding Rods

Parsons' Manganese Bronze

Rolled Welding Rods—The strongest bronze welding rods made for Oxy-Acetylene Welding and High Fire Brazing of Malleable Iron, Brass and Bronze. The use of Parsons' Manganese Bronze Filler Rods in brazing malleable iron results in the strongest possible weld or braze and insures satisfactory work.

We also furnish Welding Rods of Cast Iron, Copper Covered Iron and American Iron for welding steel, Vanadium Steel, Nickel Steel, Cast Aluminum, Drawn Aluminum, Soft Brass and Phosphor Bronze, also Steel Electric Welding Rods both flux covered and uncoated.

Cramp's Cast Iron Solder

for repairing Scored Cylinders and Water Jackets, etc. Thoroughly tried for several years by our customers and found entirely satisfactory.

Cramp's Aluminum Solder

A joint properly made with this solder is stronger than the original casting and is preferable to a welded joint.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

The William Cramp & Sons Ship & Engine Building Co., Philadelphia

Dixon's Graphite Rods and Plates for Welding

MADE IN ALL DIAMETERS, LENGTHS AND SIZES

Small diameter rods are sold in 4, 6 and 8 inch lengths. The shorter the rod the less breakage in shipping.

Also, Dixon's Graphite Welding Putty. In 5 and 10 lb. cans.

Dept. 202-A

JOSEPH DIXON CRUCIBLE CO.

JERSEY CITY, N. J.

D X N TRADE MARK

ESTABLISHED 1827

"RACO" WELDING WIRES

America's Standard

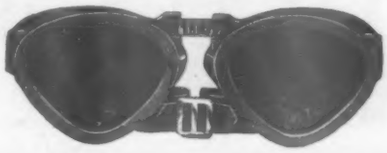
All "Raco" Welding Wires are guaranteed to meet the American Welding Society specifications in every particular, and in addition are subject to rejection from any cause whatsoever.
The well established policy of THE REID-AVERY CO. to specialize in welding wire only insures absolute satisfaction to our customers. Lowest prices consistent with unvarying quality, prompt attention to orders, unlimited guarantee.

RED LABEL (Iron) - - for Oxy-Acetylene Welding
BLUE LABEL (Mild Steel) - - for Electric Welding
HIGH CARBON, for both Arc and Acetylene Welding

THE REID-AVERY CO., Inc.

21st and Washington Ave., Philadelphia, Pa.

When you think
of good welding
there is only
one
welding goggle



Willson No. L1 is the highest type of welding goggle ever offered. It keeps welders good-natured and draws out their best work.

Price $432.00 per gross including metal cases (or $3.00 per sample pair) f.o.b. Reading.

WILLSON GOGGLES, Inc.
Manufacturers of goggles, respirators and welding helmets
READING, PA.

Welding Rods—

"Seneca Gas Weld"

"Seneca Electro Weld"

These rods are made from specially selected stock and processes. Uniform Temper, Analysis, Gauge and Finish.

Special Soft—
Medium Hard—
Extra Hard

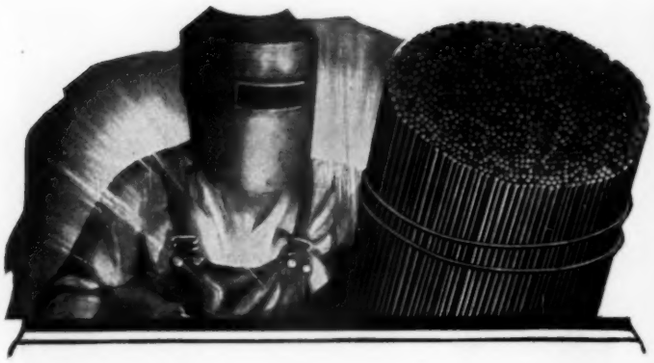
Seneca Rods are shipped to you in coils, or in straight lengths as you wish, in:—

Black—
Bright—
Coppered Finish

Your Inquiries Will Receive Prompt Attention

The Seneca Wire Mfg. Co.

FOSTORIA *Established 1905* OHIO



All welding wire may *look* alike--- *but there's a vast difference in* results

You can tell the difference in the way the metal flows and "sets." Your chemist can also determine the degree of quality by a few simple tests.

Page-ARMCO will come up to your highest expectations, for it is made from the purest of ferrous metals--- ARMCO Ingot Iron --- guaranteed 99.84% pure iron! Welds made with Page-ARMCO Welding Wire are never brittle as it is free from detrimental foreign matter.

Write for a copy of the Page Handbook giving valuable welding information. It's free---a postal will do.

PAGE

Mild Steel, Page-Armco, Page High Carbon Welding Wire *and* Electrodes

Ingot Iron

PAGE STEEL & WIRE COMPANY

An Associate Company of the American Chain Co. Inc., Bridgeport, Conn.

District Sales Offices:

Chicago New York Pittsburgh San Francisco

IDEAL FACE SHIELDS

Ideal Face Shields protect the head, chest and neck against direct and reflected rays. Easily adjusted and removed. Constructed of vulcanized fibre and aluminum, assuring durability and lightness. Hinged door allows quick inspection of work or interchange of glasses.

IDEAL WELDING GLOVE

The Ideal Glove for Electric and Acetylene Welders is made from Sheep Skin, which has been Subjected to an Asbestos Treatment and which makes it both heat resisting and fireproof.

IDEAL WELDING APRON

The Ideal Apron for Welders is made of leather which has been especially treated to stand the heat, and at the same time be very flexible and durable.

THE IDEAL FACE SHIELD CO.

468 N. Garfield Ave., COLUMBUS, OHIO

You Specify Regrinding Valves.

THEN WHY NOT

Meco MULTI-SEAT REGULATOR

MODERN ENGINEERING CO.

Main Office and Factory: 3411-13 Pine Blvd.

ST. LOUIS, MO.

Announcing

- - STOODITE - -

THE NEW *SUPER HARD* FACING METAL

Can be used with either Acetylene or Electric Arc.

For Facing Oil Well Tools, Machine Cutting and Boring Tools, Dies, Reamers, Etc.

NO HEAT TREATING OR TEMPERING REQUIRED

PRICES ON APPLICATION *STOODY COMPANY, Whittier, Calif.*

MANUFACTURERS OF WELDING ROD, ALLOY STEELS, ELECTRODE HOLDERS

If you dig into facts you will find

lives up to its slogan *"More Gas per Pound"—*

SHAWINIGAN PRODUCTS CORPORATION · NEW YORK · *Plants · Shawinigan Falls, Quebec, · Keokuk, Iowa.*

Eye Protection

Goggles
Helmets
Hand Shields
Spectacles

We make all styles to meet all requirements of all safety codes.

Write for catalog.

Guaranteed Comfort - Strength - Protection - Economy

STRAUSS & BUEGELEISEN
30 Front Street - BROOKLYN, N. Y.

ACME
RIVET ELECTRICALLY
WELD

High in Efficiency
Immediate Delivery
Low in Price
All Styles and Sizes

Acme Spot Welder

Write for detailed information and prices

Acme Electric Welder Co.
Bourse Bldg., Philadelphia, Pa.
Los Angeles, 5615 Pacific Blvd.

Weld Metal

Grain structure is one of the determining factors of the physical properties of high grade steel.

In welding steel to steel, the grain structure of the weld metal is also one of the vital factors in the strength, toughness and resistance to impact of the weld.

The UNA process of welding so successfully used in the Electric Railway Industry, in welding high carbon rail steel to low carbon plate steel easily controls the grain structure of the weld metal.

This same principle of grain refining can be applied in the solution of your welding problem.

THE UNA WELDING & BONDING CO., Cleveland, Ohio

Welding Processes
Welding Rods

UNA PRODUCTS

A.C.—D.C. Welders
Welding Supplies

Prices Reduced!

New Methods In Manufacture Enable Us To Reduce Prices

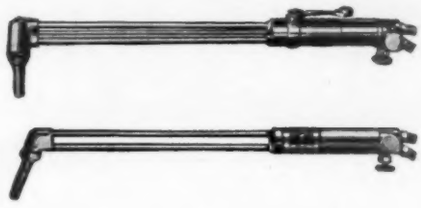
25%

BLOWPIPES for Radiator repairing, light brazing, heavy brazing, lead burning and for heating work to be welded by the oxy-acetylene process.

Let us know your requirements and we will give you the benefit of our many years' experience in blowpipe work.

Our catalog "BX" illustrates and describes them all. Ask for it.

BUFFALO DENTAL MANUFACTURING CO.
BUFFALO, N. Y., U. S. A.



K-G TORCHES REGULATORS COMPLETE UNITS

K-G WELDING AND CUTTING CO., Inc.

Home Office and Factory: 556 W. 34th St., New York City

DISTRIBUTORS & SERVICE STATIONS:—

O. W. Adams & Co., Mamaroneck, N. Y. New England.
Welders Supply Co., 700 McCulloh St., Baltimore, Md.
Charles C. Ebright, 1121 North Ashland Ave., Chicago, Ill.
J. W. Evans & Son, Tompkinsville, Staten Island, N. Y.
Albany Welding & Boiler Works, 40 Madison Ave., Albany, N. Y.
H. Harrison Kress, 1718 Sansom St., Philadelphia, Pa.
Gaul, Derr & Shearer Co., 16th & Fairmont Ave., Philadelphia, Pa.
Welding & Supplies Co., 1142 Ontario St. East, Montreal, Que.
Welding & Supplies Co., Toronto, Can.
Weldit Acetylene Co., 144 W. Larned St., Detroit, Mich.
A. G. Sprague Co., 870 Amboy Ave., Perth Amboy, N. J.
W. C. Swift, West Alexandria, Ohio.
Welders Service Co., Library Rd., Pittsburgh, Pa.
Passaic Bergen Welding Co., 650 Main Ave., Clifton, N. J.
Passaic Bergen Welding Co., 356 Fair St., Paterson, N. J.
Sutton-Garten Co., Indianapolis, Ind.

I.O.C. SYSTEM

INDUSTRIAL GASES

OXYGEN HYDROGEN
ACETYLENE NITROGEN

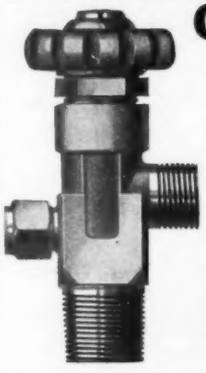
Quick shipment and low prices. Also cylinders, valves, Eyosee and International welding and cutting torches, regulators, welding wire, cast iron and aluminum rods, fluxes, plain and armored rubber hose, asbestos pads and paper, goggles, etc. All equipment fully guaranteed. Write for catalog and prices.

American Pioneer Manufacturers of Oxygen.

International Oxygen Company

Main Offices: NEWARK, N. J.
Branch Offices: New York, Pittsburgh, Toledo.

SHERWOOD HIGH-PRESSURE CYLINDER VALVES



for oxygen, hydrogen, carbon dioxide, argon, helium, etc.

These valves open easily, close tightly and have four times ordinary strength. No sticking or distortion of internal parts. Made in the light of 27-year experience and have given 20 years of constant service. Over 75 per cent of sales are on repeat orders. Write for Bulletin 10.

Sherwood Manufacturing Company,
1712 Elmwood Ave. Buffalo, N. Y.

SHERWOOD
A GOOD NAME TO REMEMBER WHEN BUYING POWER PLANT and INDUSTRIAL SPECIALTIES

FOR SALE
Oxweld Gas Generator

Capacity 500 lbs. Low Pressure
Duplex Type Acetylene Generator
Practically New
Used only a few weeks
Will sell cheap

THE EDWARDS MANUFACTURING CO.
Fifth and Culvert Sts., Cincinnati, O.

SERVICE RIGHTS

for sale on a number of Prest-O-Lite WK welding cylinders

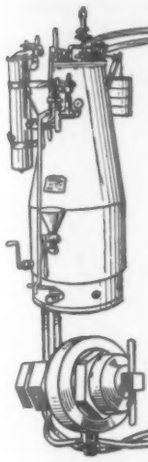
WM. RUDOLPH

452 Broadway Paterson, N. J.
Phone—Sherwood 4789

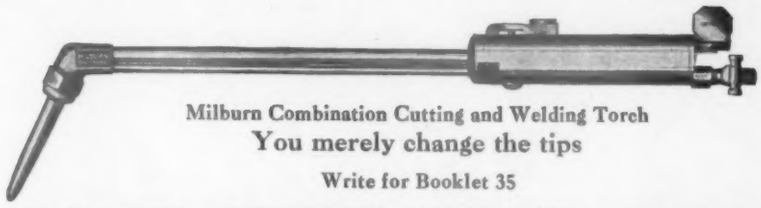
WELDING SUPPLY DEALERS

Do your customers know how best to use the apparatus you sell them? The best way you can serve them in this respect is to furnish them The Welding Engineer, and The Welding Encyclopedia. Write for our plan.

The Welding Engineer Dealers Service Dept.
606 S. Dearborn St., CHICAGO

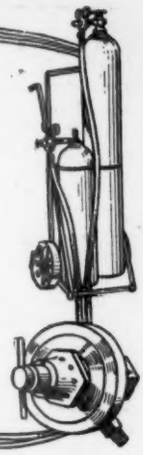


WELDING AND CUTTING TORCHES, REGULATORS, GENERATORS and PREHEATERS



Milburn Combination Cutting and Welding Torch
You merely change the tips
Write for Booklet 35

THE ALEXANDER MILBURN COMPANY 1416-28 W. BALTIMORE ST. BALTIMORE, MARYLAND



"M-W" WELDING RODS

Not simply wire cut into short pieces, but Iron and Steel made to analysis and carefully drawn or cast.

A rod for every purpose.

Samples on request.

Morris, Wheeler & Co., Inc.

Philadelphia's Largest Steel Warehouse since 1828.

301 South 30th St., Philadelphia, Pa.

THE SUPERIOR OXY-ACETYLENE MACHINE CO.

HAMILTON, OHIO, U. S. A.

MANUFACTURERS OF

TORCHES (that will not flash back) for Welding, Cutting, Lead Burning, Carbon Burning, Soldering and Brazing.

REGULATORS: 2-inch dia. up to 3-in. dia. (either with or without gauges).

SPECIAL BRASS PARTS Welding, Cutting, Lead Burning and Carbon Burning. Outfits complete. Acetylene Generators, both Portable and Stationary.

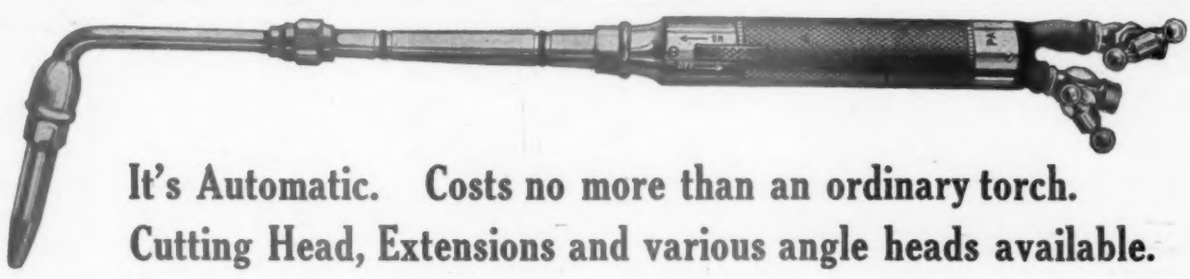
CAST IRON WELDING RODS—all sizes, cast in Round, Hex. or Square, high in silicon, gives a nice soft weld.

Shipco Steel,	Tobin Bronze,	Aluminum Solder,	Goggles,	Ladles,
Swede Steele,	Naval Bronze,	Carbon Rods,	Fluxes,	Post Builders,
Vanadium Steel,	Aluminum (CAST),	Carbon Paste,	Hose,	Plate Burning Racks,
Nickel Steel,	Aluminum (DRAWN),	Asbestos Paper,	Lead Pots,	Lead Molds,

Drills—Grinders—Preheaters—Trucks (Write for complete Catalog.)

(AGENTS WANTED IN UNOCCUPIED TERRITORY)

WE REPAIR ALL MAKES OF TORCHES, REGULATORS AND GAUGES



It's Automatic. Costs no more than an ordinary torch.

Cutting Head, Extensions and various angle heads available.

Manufactured and Patented by

UNITED STATES WELDING CO., Inc., Minneapolis, Minn., U. S. A.

MAKERS OF FAMOUS "U. S." WELDING AND CUTTING APPARATUS

Welding Carbon Products

National Round Welding Carbons
National Welding Carbon Plates
National Welding Carbon Paste
National Welding Carbon Flour

Our welding carbon products are designed especially for welding operations

National Carbon Company, Inc.
Cleveland, Ohio San Francisco, Cal.

Canadian National Carbon Co., Limited
Factory and Offices: Toronto, Ontario

Specify—MOREY

A flux of scientific combination with Smile-As-You-Work characteristics.

Chemical changes neither create nor destroy matter. By chemical means matter may be converted into new forms having different properties.

Insist on—*Morey*

A Chemical Conversion. Sold and used by the most prominent.

Manufactured by
Morey Flux & Chemical Company
Wilmington, Del. U. S. A.

WELDING RODS

(ALL METALS)
AT GREATLY REDUCED PRICES
ALSO FLUXES OF ALL KINDS
ALL OUR SUPPLIES ABSOLUTELY GUARANTEED
SEND FOR NEW PRICE LIST AND SAMPLES

Bierman-Everett Foundry Co.
133-153 So. 20th St., IRVINGTON, N. J.

QUASI-ARC SYSTEM

L-W. 110 V. WELDER

Manufacturer of:
A. C. & D. C. Welding Sets
Dealer in Weldtrodes:
Mild Steel
High Carbon
Manganese
Cast Iron
Gives Machinable Weld

H. E. STEINBOCK
Peekskill, New York

IMPERIAL WELDING AND CUTTING EQUIPMENT
OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch —are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 817 S. Racine Ave., Chicago

REBUILT WELDERS

We buy, sell, rent, exchange and repair
ARC WELDERS AND SPOT WELDERS.
Every machine tested in actual welding service and guaranteed.

GOODMAN ELECTRIC MACHINERY CO.
126 Green Street Newark, N. J.

ARC WELDING EQUIPMENT

TRANSFORMERS, MOTOR & GASOLINE ENGINE GENERATOR SETS
WELDING ACCESSORIES

ALLAN MANUFACTURING & WELDING CO.
724 Washington St., Buffalo, N. Y.

SERVICE RIGHTS
on
Prest-O-Lite Welding Cylinders
BOUGHT AND SOLD

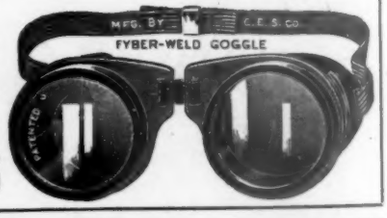
ALFRED E. CORP
40 Mathewson St. Providence, R. I.

DRILL—GRIND—POLISH
STRAND
FLEXIBLE SHAFT EQUIPMENTS
Several Sizes

N. A. STRAND & CO.
5001 N. Lincoln St. CHICAGO

"CESCO" Fyber-Weld Goggle
No. 510

CHICAGO EYE SHIELD CO.
2300 Warren Ave., CHICAGO



WELDING ROD HOLDERS

For the Oxy Acetylene Welder.
Price $1.00

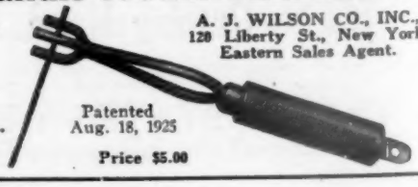
ALL STEEL WIRE BRUSHES
45c Each, 3 for $1.00

Write for Dealers' Prices

C. SORENSEN, 18 E. 16th ST., CHICAGO, ILL.

Welding Handle Troubles Eliminated

A. J. WILSON CO., INC.,
120 Liberty St., New York
Eastern Sales Agent.



STOODY CO.
WHITTIER, CAL.
Manufacturer

Patented
Aug. 18, 1925

Price $5.00

The Welding Encyclopedia

Fourth Edition

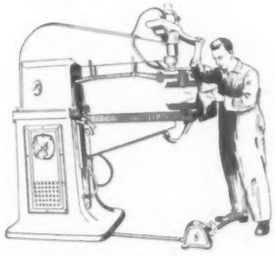
The most complete compilation of welding information ever published, and

No matter how much welding you do—
No matter what kind of welding you do—
No matter what welding process you use—

If you Weld, you need this book

FOR THE OXY-ACETYLENE WELDER

FOR THE ELECTRIC ARC WELDER



FOR THE RESISTANCE WELDER

FOR THE THERMIT WELDER

It describes in detail the theory and practice of every welding process.

It tells how to weld every weldable metal by each of the welding processes.

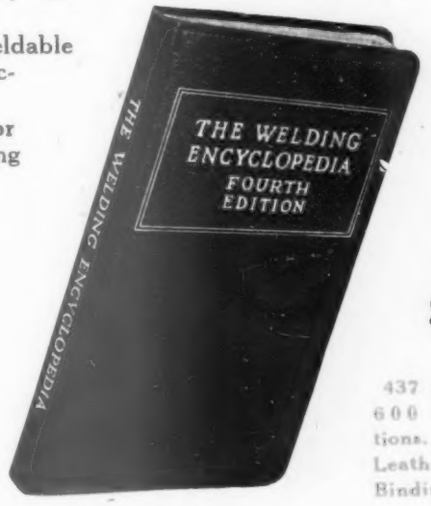
It gives detailed instructions for handling the important welding jobs, such as boiler welding sheet metal welding, tank welding, pipe welding, etc.

It tells how to prepare parts for welding.

It tells how to install and care for welding equipment.

It explains the meaning of all words and terms found in welding literature.

It tells where to buy all standard makes of welding apparatus and supplies.



PRICE
$5.00

437 PAGES
600 Illustrations. Flexible Leather Grain Binding.

For All Welders

CONTENTS

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.

2. Oxy-Acetylene Welding.—Aluminum, Steel, Cast Iron, Brass, Bronze. (Full instructions for welding each of these metals.)

3. Electric Arc Welding.—Complete instructions for welding all metals, studding, cutting, etc.

4. Electric Resistance Welding.—Includes Butt Welding, Line Welding, Percussion Welding and Spot Welding.

5. Thermit Welding.—The most complete treatise on this process ever published.

6. Boiler Welding.—An important subject for the welder to study.

7. Complete chapters on Pipe Welding, Rail Joint Welding and Tank Welding, explaining procedure in detail.

8. Heat Treatment of Steels.

9. Rules and Regulations.—What can be welded and what cannot be welded. Rules also govern the installation and operation of equipment.

10. Complete instruction courses in Electric Arc Welding and Oxy-Acetylene Welding. Lessons, exercises, Reference Readings Examinations.

11. Charts and Tables.—A fund of welding information at a glance. Includes color chart showing colors at various temperatures, and color chart showing proper adjustment of oxy-acetylene welding flame.

12. Condensed Catalogs—Up-to-date information about the leading makes of welding apparatus and supplies. The Buyers' Index is a convenient and reliable guide to the man who purchases or recommends welding apparatus.

SEND THE COUPON TODAY

AND YOU WILL RECEIVE YOUR COPY BY RETURN MAIL

The Welding Engineer Publishing Co.,
608 S. Dearborn St., Chicago, Ill.

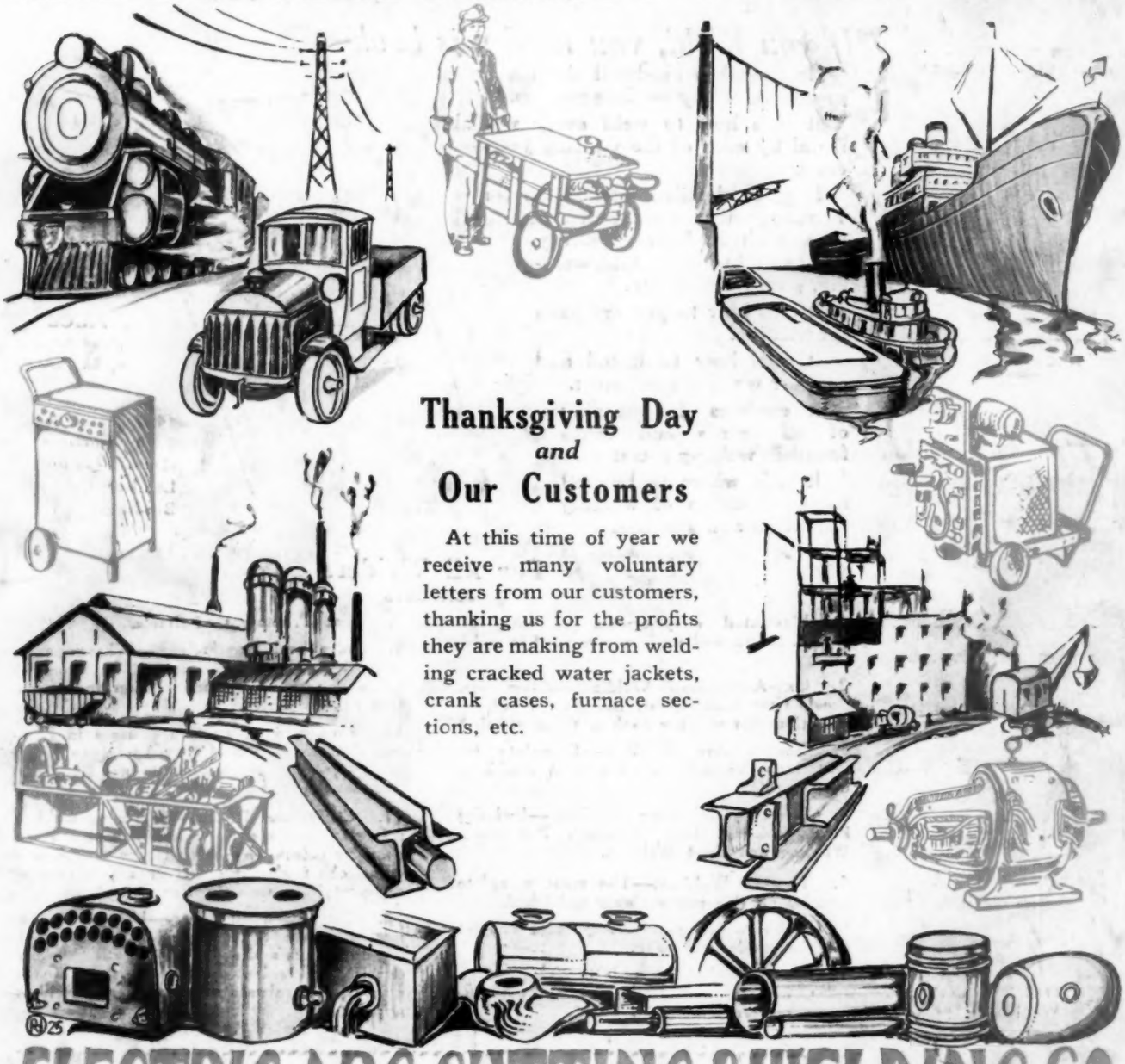
Please send me a copy of The Welding Encyclopedia, Fourth Edition, for which find enclosed five dollars. I understand that I may keep it for five days for examination and if it is not satisfactory I may return it and you will refund the purchase price.

Name .....

Street .....

Postoffice .....

ELECTRIC ARC WELDING



Thanksgiving Day
and
Our Customers

At this time of year we receive many voluntary letters from our customers, thanking us for the profits they are making from welding cracked water jackets, crank cases, furnace sections, etc.

ELECTRIC ARC CUTTING & WELDING CO.

152-158 JELLIFF AVE., NEWARK, N.J., U.S.A.